NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

DISCUSSION OF A LOCAL AREA NETWORK FOR THE MARINE CORPS INFANTRY BATTALION

by

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March 1985

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Date Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Discussion Of A Local Area Network For The Marine Corps Infantry Battalion	5. TYPE OF REPORT & PERIOD COVERED: Master's Thesis March 1985
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): William C. Gawler Jr.	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Postgraduate School Monterey, California 93943	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Postgraduate School Monterey, California 93943	12. REPORT DATE: March 1985
	13. NUMBER OF PAGES: 113
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report)
	15a. DECLASSIFICATION/ DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Distributed data processing
Local area network
Microcomputer
Management control

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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S/N 0102-LF-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. (Cont.)

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Discussion of a Local Area Network For the Marine Corps Infantry Battalion

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
March 1985

ABSTRACT

This paper discusses the possibility of implementing a Local Area Network (LAN) within the Marine Corps Infantry Battalion. The idea of a LAN is proposed as an automated alternative to the status quo. As a mechanism of Distributed Data Processing (DDP), the LAN is used to highlight one possible migration path along which the Battalion Consolidated Administration Center (BCAC) concept may evolve technologically. Current problems and functional requirements are identified and they provide the foundation upon which the LAN topology is based. Implementation guidelines and related issues are included in the discussion. A LAN benefits-analysis is presented in order to demonstrate obtainable productivity gains in dollar terms. Finally, this thesis should stimulate thought for developing a Battalion-Regiment-Division network and illuminate the feasibility of automating other battalion-like units within the Marine Corps.

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ACKNOWLEDGMENT

I would like to gratefully acknowledge the valuable assistance provided by several individuals during the development of this thesis. Professor Schneidewind's extensive networking expertise served to ensure the technical integrity of the LAN concept promoted in this study. Lieutenant Colonel Don Bonsper's career infantry experience and knowledge of automation techniques helped in molding the LAN concept to fit the organizational setting of the Marine Corps infantry battalion. His thorough and timely review of individual chapters aided the author in steadily progressing toward the finished product. My sister, Gretchen Cawthon, furnished help by participating in the statistical analysis of questionnaire data. Most of all, I acknowledge the monumental support provided by my wife, Elaine. Her expert typing skills, keen editing abilities, and constant encouragement contributed in a significant way throughout the thesis process.

I. INTRODUCTION

A. THESIS CONCEPT

In an office information systems equipment feasibility study conducted in 1984 by the 1st MARINE DIVISION, the following problem was identified:

> "Our office information systems are not developing and distributing, or managing information requirements at the desired quality level and time limits throughout the Division's organizational structure." [Ref. 1].

The conceptual basis of this paper is to construct a framework within which the issues raised by this problem, as they pertain to the infantry battalion, may be discussed.

B. PURPOSE

The purpose of this thesis is multifold. The first purpose is to propose a specific automation alternative to the infantry battalion administration status quo in the form of a Local Area Network (LAN). Second, this study highlights the need for the battalion consolidation administration concept to evolve from its present state. The third purpose is to promote the concept of Distributed Data Processing (DDP) vice stand-alone, centralized computing for the infantry battalion. The fourth purpose is to describe a model LAN foundation, at the battalion level, upon which thought for a Battalion-Regiment-Division network may eventually stem. The last purpose is to stimulate thought for developing a Marine

Corps-wide plan for automating battalion-like units both in the Fleet Marine Forces and in other sectors of the Marine Corps organization. Finally, it is not the purpose of this study to promote a specific vendor's product or equipment.

C. SCOPE

The thrust of the thesis is confined to investigating the functioning of administration within the infantry battalion, organic problems, and an applicable alternative. Discussion of certain issues related to the principal topic will be mentioned on a fundamental level only. It is not the intent of the paper to propose a universal solution to general administrative processing problems in the Marine Corps.

Upon initiation of this research, it became readily evident that a demarcation line between garrison automated systems and a system capable of deploying operationally with the infantry battalion distinguished two possible approaches such a study might foster. In electing to limit the discussion principally to a garrison environment, it is of paramount importance to recognize the critically significant issues concerning an operationally deployable local area network for the Marine Corps infantry battalion. Indeed, during the course of interviews with Marines in many battalions and at all levels, one key question cried out: Can I take such a system with me to the field? Though, this study does not directly address this question, it is one

that must be considered prior to implementing any planned automated systems. Perhaps, this concern portends the future, somewhat: shoot, move, communicate, and compute!

D. METHODOLOGY

The methodology employed in developing a balanced discussion of pertinent issues entailed synthesizing information acquired through interviews, personal visits to the 1st and 2nd MARINE DIVISIONs, questionnaires, personal infantry experience, and current literature. The discussion approach employs traditional academic conventions which are reinforced with Marine Corps Life Cycle Management for Automated Information Systems (LCM-AIS) considerations. The objective in blending intellectual thought on the subject matter and LCM-AIS elements is to instill a dynamic flavor, such that real world action on the ideas may be better facilitated if necessary.

E. ORGANIZATION

In the next chapter, the nature of infantry battalion administration is discussed within the context of the consolidated administration era and current computing trends. The closing section of chapter II identifies the problems with the current system in the Mission Element Need Statement (MENS). Chapter III presents an analysis of data obtained from the Infantry Battalion Administration Questionnaire distributed to eight battalions. Inferences from the

statistics generated are used to validate the needs described in the MENS. The next section in Chapter III identifies the functional requirements of the infantry battalion by responsibility area. Then, new capabilities requirements and LAN design parameters are listed. Chapter IV presents the local area network alternative. The discussion includes the network concept, topology, resources, implementation guidelines, related implementation issues, and a cursory LAN benefits-analysis. The paper concludes in Chapter V by stating the conclusions inferred by the discussion and a list of specific recommendations for Marine Corps policymakers.

II. INFANTRY BATTALION ADMINISTRATION

A. BACKGROUND

The Marine infantry battalion is the basic tactical unit of ground combat power in the Marine Corps. It is a flexible organization which is able to maneuver independently on the battlefield or task-organize for the conduct of amphibious or air-ground task force operations [Ref. 2].

The Marine Corps' twenty-seven infantry battalions deploy on worldwide operations and conduct peacetime unit-training and battalion administration while on a garrison schedule. The battalion commander has an executive staff, special staff, and five subordinate commanders that share in the responsibility for supervising the daily routine of unit training and battalion administration. Figure 2.1 delineates the staff/command structure (Special Staff officers are broken out individually under the heading "Special Staff" for clarification. It is recognized that Executive Staff sections have cognizance over them).

The infantry battalion's mission has endured almost without change over time. This is not the case with respect to the conduct of battalion administration. It will become evident shortly that evolutionary changes have embraced the business of taking care of administrative matters within the battalion. As the Marine Corps advances further with computer

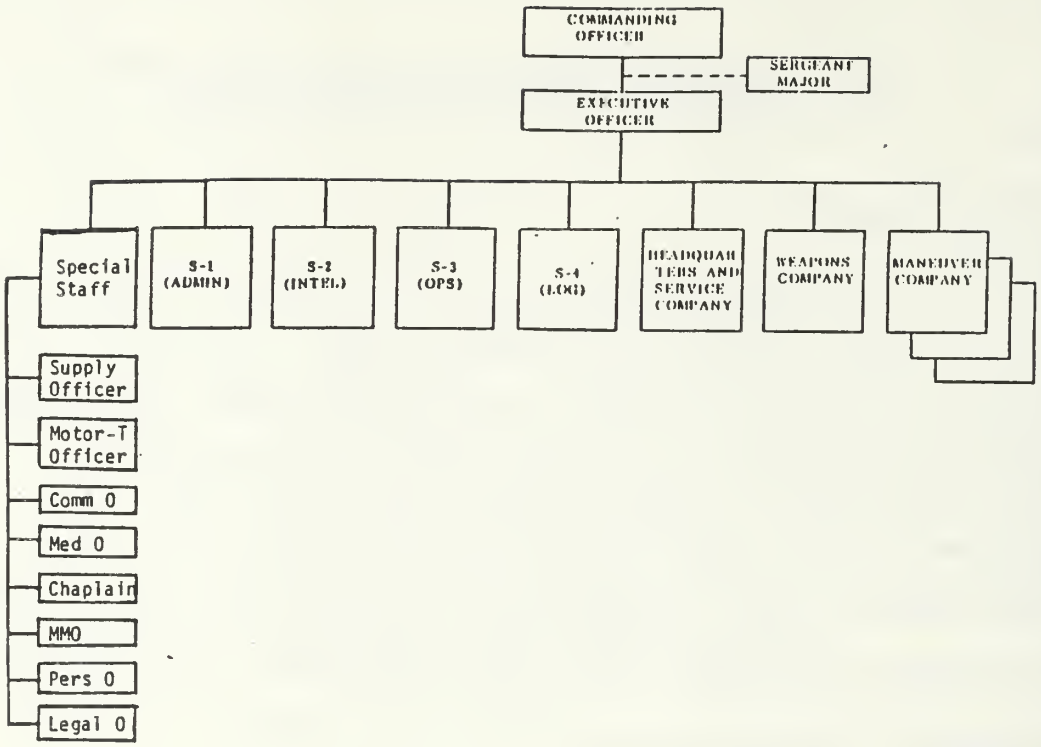

Figure 2.1 Infantry Battalion Staff/Command Relationship

technology and automation techniques, there are likely to be more changes.

B. THE CONSOLIDATED ADMINISTRATION ERA

In 1978, the Commandant of the Marine Corps directed the consolidation of administration at the battalion level within all ground Fleet Marine Force units [Ref. 3]. Under the outgoing system, the battalion's five companies exercised local autonomy with regard to personnel administration functions and responsibilities. The company office maintained personnel, training, and pay records, held directives and publications, and performed reporting to battalion

headquarters. Though essential information was always immediately accessible, this time-tested manual system began to experience an increase in complexity and volume of administrative requirements over a period of years. These pressures, added to the fact that manpower increases on the small-unit level never materialized, placed severe strains on the companies' ability to meet requirements. The leadership response to this dilemma by company commanders was to augment existing clerical strength from sources within the company. This approach was viewed to have a detrimental impact on operational readiness [Ref. 4].

Quoting from the 1st MARINE DIVISION's Battalion Consolidated Administration Manual (1981):

> "Consolidated administration (CONAD) at the battalion level is considered to be the most efficient method of accomplishing the myriad requirements of the present day (underline mine) personnel administrative mission with available resources (underline mine)." [Ref. 5].

The principle underlying the consolidated administration concept is that all reporting and recording of personnel information is accomplished within the Battalion Consolidated Administration Center (BCAC). The new company office no longer has access to typewriters or clerical personnel and maintains a minimum of directives and publications. The leaders at the company level serve their Marines by submitting "Personnel Action Requests" (PAR) to the BCAC. The BCAC serves the company by responding to all PARs

received. It is in this iterative fashion that battalion administration has been conducted since its inception in 1978.

Headquarters Marine Corps intended that consolidated administration free company level leaders from the burden of personnel administration such that they may function more effectively as leaders and conduct improved mission oriented training. Specific goals include:

- "More effective employment of limited, qualified administrators at the supervisory level
- Enhanced quality control
- Optimum utilization of organic equipment
- Reduction in the number of directives and publications held in the battalion
- Integration of local administrative functions into the Joint Uniform Military Pay System/Manpower Management System (JUMPS/MMS)." [Ref. 6].

The above list illuminates two fundamental objectives. That is, the new system must increase both the efficiency and effectiveness of battalion administration. The former objective was to be furthered by centralizing administrative functions to achieve economies of scale. The latter objective involved the conversion of battalion administration from a manual to an automated system. Specifically, the BCAC now employs a single, IBM Model 4110, Series 1, "Green Machine" minicomputer for the processing of administrative requirements. The premise underlying this automation step is that timeliness, completeness, accuracy, and overall quality of

administrative output might be improved, such that the command functions better in garrison.

Consolidated administration is firmly in place. It is the framework within which this paper discusses the possibility of further automation of administrative processes within the infantry battalion. The following observations highlight the key points of the consolidated administration concept:

- Centralization of administrative functions moves essential information away from the user which results in increased access times and degraded data integrity.

- BCAC's "Green Machine" is supersaturated with user demands. There are two reasons for the current situation. First, the consolidated administration concept was promoted within the context of yesteryear's available resources. That is to say that the "Green Machine" does not have sufficient built in storage and processing capacity to cope with today's increasing volume of user requirements. The modest processing power of the "Green Machine" is first dedicated to performing Class I data transactions (Transactions posting to Marine Corps organizations external to the battalion). This leaves much less time available for satisfying the needs of companies. The second reason is that one CPU for processing battalion requirements is not enough. This results in significant queueing times for competing terminal operators, each of whom is attempting to respond to company PARs.

- The fact that consolidated administration was introduced in 1978 in order to meet, then, present day administrative requirements, and that user demands now exceed capacity, draws attention to the absence of planning for system growth and the current need for migration into the next generation of battalion administration technology.

This section has described the consolidated administration environment since its inception in the mid-seventies. The following section will extend the description into the

eighties and illuminate issues which play a role in the discussion of improved automation capability for the infantry battalion.

C. COMPUTING THE EIGHTIES

Until the mid-seventies, most computing in the private sector employed a large, centralized computer [Ref. 7]. The Marine Corps analog to this trend is found in the establishment of consolidated administration in 1978. At this time, the Marine Corps instituted the centralization concept at the battalion level and it put in place single IBM series 1 computers to do the job. While the Marine Corps was busy centralizing administrative functions in the BCAC and battalion headquarters, the private sector began to capitalize on the benefits of decentralized computing. Reasons given for this apparent lag in timing behind the private sector may include cautious consideration of change, availability of budget resources for ADP acquisition, and a scarcity of commitment and knowledge about how to convert battalion administration from a manual to an automated system. Though not perfectly synchronized with current automation trends in our society at large, it is important to recognize that Marine Corps automation developments on the battalion level closely parallel them.

George Champine states:

> "A significant problem today for all large organizations is obtaining shared access to information." [Ref. 8].

Data processing personnel began to grapple with the importance and difficulty of this issue in the mid-seventies. It was during this period that the centralization/decentralization debate began. As will be discussed in the following section, this controversy has shaped the nature of computing for the past decade and it continues to do so in the eighties. As the Marine Corps evolves in the realm of computing on the unit level, it, too, must attempt to answer the questions posed by the centralization/decentralization debate.

1. The Centralization/Decentralization Debate

In his insightful article entitled, "Centralized Versus Decentralized Computing: Organizational Considerations and Management Options," CACM, John Leslie King makes the following statement:

> "The fundamental question, when one looks carefully at the issue of whether to centralize or decentralize computing, is who will have control over procurement, use, and management?" [Ref. 9].

The issues pertinent to the Marine Corps are:

- Should ADP resources for the infantry battalion be procured locally by the MARINE DIVISION, or should the Information Systems Branch (Code CCI) at Headquarters, U.S. Marine Corps conduct a Marine Corps-wide acquisition strategy?

- Where are the resources to be placed within the battalion; centralized at the battalion headquarters level, decentralized at the company level, or a combination of the two extremes?

- Given the range between extreme computing centralization or decentralization, how will the infantry battalion chain of command and staff relationships manage any ADP resources acquired?

Each extreme has both advantages and disadvantages. Information processing control centralized within the BCAC and battalion headquarters ensures good standard operating procedures (SOP) adherence, battalion command policy conformance, and consistent data integrity. Decentralization of information processing control on the company level, in staff sections, and commodity areas enables company commanders, key staff officers and assistants, and commodity managers a degree of flexibility in selecting courses of action from available options. Additionally, decentralizing information processing control compels key personnel to take responsibility for decisions and actions. This condition is often a performance incentive. Centralizing the physical location of functions, responsibilities, and processing capabilities in the BCAC and battalion headquarters exploits economy of scale benefits and promotes consistency of operations within the organization. On the other hand, physical decentralization promotes organizational flexibility and facilitates a quicker reaction to, often, unexpected developments. An example of such a situation where there is a need for immediate processing and use of information is in the case where an infantry battalion receives twenty-four hour notice to mount-out for a deployment. A decentralized system of processing capability speeds up the development of

personnel and equipment rosters, etc. by allowing individual companies, staff sections, and commodity areas to take responsibility for generating and submitting time-essential information. Such an application is realistic and bears directly upon mission-readiness.

The centralization/decentralization controversy, then, is one where the benefits of centralized control, consistent battalion operations, and economies of scale are poised against the needs of company personnel, staff officers and assistants, and commodity managers for immediate access to information and computer processing capability. King reduces the description of the debate to one of efficiency versus effectiveness [Ref. 10]. It is readily recognized that the "Green Machine's" processing of user requirements is efficient and represents an improvement over the previous manually-based system. However, the complement to this question must be posed. Does a single computer with modest processing capability and availability problems (i.e., multiple terminal operators competing for computer time), which faces a trend toward increasing complexity and volume of user requirements, produce results that are timely, accurate, and useful to the extent that the battalion is more effective in administration and, consequently, training? Distributed processing is the technological attempt to address the efficiency versus effectiveness element of the centralization/decentralization debate. The

following section illuminates the concept of distributed processing.

2. Trend Toward Distributed Processing

Though there is no consensus on the definition of distributed processing, a useful one is provided by George Champine:

> "Distributed computing is the functional distribution and cooperative processing of applications among multiple computing nodes interconnected by a communications network for information transfer." [Ref. 11].

He goes on to say that the motive force behind the transition to distributed computing systems has been increasing pressure to improve organizational efficiency amidst the volatile dynamics of a changing computing environment. Elements of the changing computing environment which have influenced the trend toward distributed data processing (DDP) include technological advances and organizational responses to centralization. Since the early seventies, Very Large Scale Integration (VLSI) circuitry technology has caused the cost of microcomputers and memory to drop dramatically because the number of components per chip has increased significantly. Thus, a larger number of smaller, yet powerful, computing machines represented an attractive alternative to large, centralized systems. Concurrently, system users became increasingly dissatisfied with the inability of centralized data processing departments to better respond to their needs. This "user rebellion"

further catalyzed the evolution towards distributed processing.

James Martin says that:

> "Distributed Data Processing can bring logic, data storage, or computing power to the end-user location and by doing so can decrease staff (underline mine), enable work to be done more efficiently (underline mine), or permit end-user management more authority and responsibility (underline mine)." [Ref. 12].

Specifically, DDP can accomplish three objectives for the infantry battalion:

- Data can be captured closer to its source at company offices, staff sections, and commodity areas, thus, increasing data consistency and integrity and decreasing access time

- Current pen-and-ink techniques in the three areas above can be automated, thereby assisting local functional management of administrative matters

- Data can be transmitted quickly and with accuracy to battalion headquarters, such that battalion-applicable command decisions can be made in a timely manner

One observation about the trend towards DDP is that decentralization of functional management processes to company offices, staff sections, and commodity areas can be accomplished while retaining a centralization of command and control processes within the battalion headquarters and the BCAC. Secondly, the DDP trend in progress now should serve as a signal to Marine Corps policymakers that evolution of thought and technology is taking place in the computing environment. The notion of migration to higher technologies and planning for such transitions is the matter of the section that follows.

3. Framework for Growth

The principal theme underlying the material throughout this chapter is best summarized by a quote from Judson Breslin's enlightening book, Distributed Processing Systems: End of the Mainframe Era?:

> "It is management's responsibility to keep the organization in phase with the real world." [Ref. 13].

The "real" computing world has been changing rapidly for years. There are drastic costs associated with an organization's comfort with the status quo. First, by not evolving with technology over time, the phenomenon of migration lockout can occur [Ref. 14]. This is where an organization is prevented from joining a computer manufacturer's "migration path" to next-generation systems because of a proliferation of varied end-user machine types, unmonitored network design, or neglecting to upgrade systems beyond their practical life. The result is that the organization cannot convert from today's system to the next one without severe difficulty and prohibitive costs. Secondly, there is the opportunity cost of failing to take advantage of emerging technology which can measurably improve both functional efficiency and quality of results.

Richard L. Nolan postulated in 1974 a model of electronic data processing (EDP), which included four stages of growth: initiation, expansion, formalization, and maturity [Ref. 15]. The thesis expressed in Nolan's

acclaimed model is that to efficiently capitalize on developing computer technology, it must be managed. Further, newly acquired technology must be made compatible with the organization's ability to assimilate new methods of performing existing tasks better. As in the case of computer manufacturers establishing migration paths for customers, user-organizations must plan for change.

The Marine Corps should establish a planned infrastructure, within which the evolution of automation technology for the infantry battalion can take place. In software engineering, the terminology of top-down and bottom-up design is used to describe approaches to software applications development. Top-down planning for DDP within infantry battalions can be initiated by the Information Systems Branch (Code CCI) at Headquarters, Marine Corps. Planning actions at this central level can include:

- Devise standards for machine and network compatibility with regard to infantry battalion ADP resources
- Establish a timetable for acquiring and implementing computer technology on the battalion level
- Specify the data-base architecture to be used
- Identify specific applications which require centralized control
- Conduct planning for migration to higher technologies
- Establish a channel of communication between computer experts at Code CCI and users in the battalion via the chain of command

Within the overall framework established by the Information Systems Branch, users on the battalion level can conduct bottom-up design such that their actions fit into the centrally planned framework for distributed data processing in the infantry battalion. Bottom-up design actions include:

- Match physical location of DDP resources with the battalion's unique requirements
- Establish internal management control techniques
- Match DDP applications with the battalion's unique requirements
- Continue to give high priority to Class I data applications
- Utilize the communication channel to the Information Systems Branch, via the chain of command, to obtain technical assistance and to highlight changing computing needs

In the next section, the Mission Element Need Statement will describe the necessity for the Battalion Consolidated Administration concept to evolve. In order to bring about such change, the Marine Corps should develop a centralized strategic framework for DDP which facilitates step-by-step growth on the unit level. Strategic considerations of such a framework of growth involve the degree of compatibility and interconnectability which is beneficial to the Marine Corps and the infantry battalion, now, and in the future.

D. MISSION ELEMENT NEED STATEMENT

The first phase in Automated Information Systems (AIS) development is the identification of the problem. The MENS presented here attempts to accomplish this task and it is in conformance with Marine Corps Order P5231.1.

1. Mission Area Identification

This MENS pertains to the administrative functioning mission area of the Marine Corps infantry battalion.

a. Mission and Authority

The mission of the Marine Corps infantry battalion is to locate, close with, and destroy the enemy by fire and maneuver, or to repel his assault by fire and close combat [Ref. 16]. The twenty-seven active infantry battalions conduct training to this end in peacetime. The National Security Act (1947) vests authority in the Marine Corps for serving as a force-in readiness and conducting amphibious operations.

b. Current Environment

During 1983, the Marine Corps implemented a restructuring of infantry battalions in conformance with the new table of organization, series 1037C. The realignment of the organizational structure came about as a result of the introduction of new weapons systems. While new organic weapons were added, a slight reduction in manpower was effected. The desired result of the reorganization is to enhance combat firepower without adding additional personnel.

This reorganization is being completed at a time when complexity and volume of administrative requirements are increasing.

The operational environment continues to reflect a high tempo of training, operations, and deployments. Infantry battalions continue to participate in eighteen-month pre-deployment training cycles. During the course of garrison periods, infantry battalions dedicate substantial time and effort toward sustaining the overall administrative cycle which is integral to preserving the required degree of functional and operational readiness.

c. Priority

The twenty-seven active infantry battalions are the cornerstone of ground combat power in the Marine Corps--the essence for which the organization is formed. The effective and timely functioning of the administrative cycle, under the aegis of battalion consolidated administration, is a demanding and incessant process which is inextricably related to the accomplishment of peacetime training and mission readiness. In this regard, any factor which impinges upon the degree of success a battalion experiences while pursuing acceptable mission readiness standards takes on an element of significance. The significance of the relationship between administrative functioning and mission readiness is mitigated, somewhat, within the context of limited resources and other pressing

programs. The current deficit woes of the federal government and proposed cutbacks in defense spending for FY'86 further describe the reality within which budget requests for battalion AIS resources are likely to be disapproved. Consequently, the mission need highlighted in this document assumes a moderate priority.

2. Deficiency

This section will define the extent to which the current information system within the battalion fails to support command functions adequately. Secondly, the specific deficient areas will be identified.

a. Scope

Five company offices, four staff sections, four commodity areas, and the Battalion Consolidated Administration Center comprise the major elements of the current battalion administration system. Each element is involved with developing, distributing, and managing information requirements. The factors which describe the magnitude of the need emphasized in this document are:

- Incomplete and inaccurate results
- Excessive time to produce routine requirements
- Low flexibility of centralized information system
- Additional, unauthorized personnel utilized to augment clerical strength in overburdened areas
- Excessive working hours for clerical personnel
- Low morale amongst clerical personnel

- Excessive time for developing information used in planning and decision-making. [Ref. 17].

b. Jobs to be Accomplished

In an exceptional and comprehensive report entitled, "Text Processing Study Of A Marine Corps Infantry Battalion," Lieutenant Colonel Steve Oren employs the systems analysis technique to identify functional requirements which are performed in a deficient manner by the current battalion administration system. The functional requirements are:

"1. Letters - includes official letters, endorsements, and Naval letters

2. Memorandums - includes intrabattalion letters

3. Reports - includes point papers, staff studies, and other intrabattalion reports

4. Special Orders - includes battalion special orders, and temporary or permissive duty orders

5. Directives - includes battalion orders, bulletins, and publications

6. Messages - includes Naval messages

7. Classified Documents - includes preparation of all classified documents

8. Forms Processing - includes, but not limited to, administrative action forms, fitness reports, promotion and commendation certificates, and leave papers." [Ref. 18].

Figure 2.2 is Colonel Oren's systems analysis depiction of the battalion administration system.

3. Existing and Programmed Capabilities

Just as the infantry battalion table of organization was restructured, changes in office administration equipment

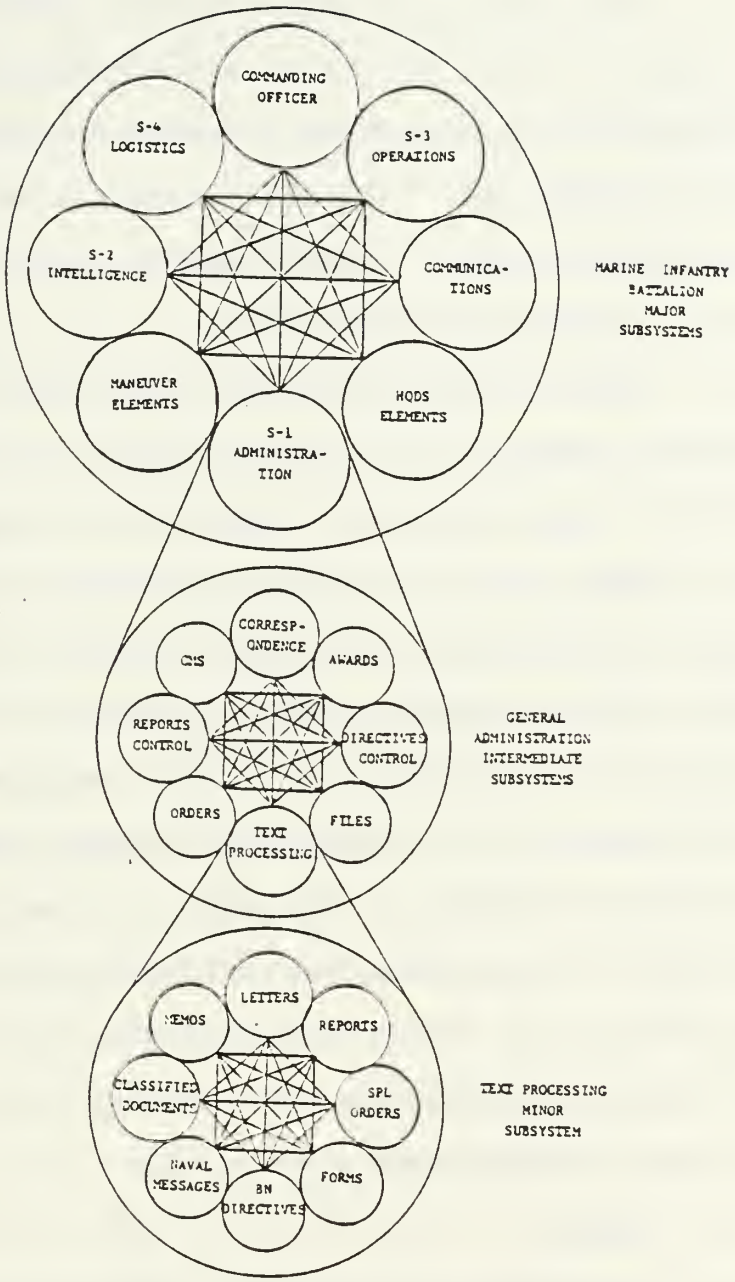

Figure 2.2 Systems Analysis View of Battalion Administration

are underway. This section will identify current and planned resources.

a. Current Capability

The functional requirements listed in section 2 are performed by means of manual and electric typewriters, microcomputers, and IBM Series 1 "Green Machines" across the spectrum of battalions. Specific resources vary, but in most instances the workload is shouldered by electric typewriters.

b. Programmed Capability

The 1st MARINE DIVISION submitted a request for microcomputer acquisition to Headquarters, U.S. Marine Corps during FY'84. Upon subsequent approval, it began placing one IBM XT System in each infantry battalion [Ref. 19]. On 5 July 1984, the Division began placing one IBM Selectric III typewriter in each company office and BCAC of each infantry battalion [Ref. 20]. During the same timeframe, one Xerox copier was placed in each battalion headquarters building. In the 2ND MARINE DIVISION, beginning in the summer 1984, one Televideo PC word processor was allocated to each battalion [Ref. 21]. It is believed that the 3RD MARINE DIVISION infantry battalions have had use of one micro-computer, each, since 1983.

c. Impact

With the complexity and volume of administrative requirements increasing and an insufficient number of clerical personnel and office automation equipment, if the status quo were maintained, the infantry battalion would continue to experience a deficiency in developing,

distributing, and managing information requirements beyond acceptable limits.

4. Constraints

The key operational constraint is the question of deploying a local area network with the infantry battalion in field conditions, aboard ship, and in a combat environment. It is suggested that a study be commissioned to explore this area in question, given the significance of the issue. Organizational limitations include buildings that are World War II vintage which are often ill-ventilated, in poor repair, cramped, and dusty. Personnel who utilize these office areas are often soiled (foreign object damage to computers) as a result of field training, smoke in confined areas (particulate matter), and consume hot and cold liquids in proximity to work areas. A technological constraint will be the ability of the proposed alternative to interface with the existing and planned array of microcomputers. It is expected that there will be difficulty in this area. The timing in satisfying the need outlined in this document should be considered within the constraints of increasing complexity and volume of administrative requirements, manpower ceilings, and piecemeal acquisition of varied vendor-products.

5. Project Management

A Steering group should be established under the aegis of the Information Systems Branch, Headquarters, U.S.

Marine Corps to study this matter. Membership should consist of Information Systems Branch personnel, Division and MAF ISMOs, a U.S. Marine Corps Comptroller representative, and a Battalion Executive Officer from each Division.

III. IDENTIFYING THE REQUIREMENTS

A. INTRODUCTION

"We need it!!!" [Ref. 22]

The above is a response from the Infantry Battalion Administration Questionnaire. The purpose of this chapter is to answer the question: To what degree is the requirement for an automated alternative to the infantry battalion status quo substantiated? The questionnaire results document problems and include inferences about the current system. Insight is provided about why infantry Marines perceive a need to improve upon the present situation. The third section of this chapter identifies functional requirements by responsibility area within the battalion. This shall graphically describe the degree to which the currently overburdened system is unable to efficiently and effectively handle an increasing volume and complexity of requirements. New capabilities requirements follow in attempt to translate existing deficiencies into specific system improvements. The concluding section proposes a desirable LAN design framework, within which a suitable alternative may be developed which will meet the battalion's needs.

B. THE INFANTRY BATTALION QUESTIONNAIRE

In order to obtain current and first-hand data about the manner in which battalion administration is conducted in

1984, a questionnaire was devised and distributed to infantry battalions. Due to its length, the questionnaire is included in an abbreviated form as Appendix A. The questions listed are those which directly yielded data presented in this research.

In designing the questionnaire, the following objectives were set:

- Obtain quantitative data about information production, distribution, and management within the battalion
- Obtain facts about current equipment, policies, and procedures in regards to administration
- Survey perceptions, opinions, and attitudes about how the current system operates
- Survey attitudes of infantry Marines toward automating the battalion administration system

In order to facilitate statistical significance of the data, certain criteria for disseminating the questionnaires were established:

- Survey a balanced cross-section of battalions across the Marine Corps
- Disseminate enough questionnaires to ensure large sample sizes for each question
- Survey a representative cross-section of staff and command billets within each battalion
- Obtain a fair distribution of ranks for personnel responding to the questionnaire
- Obtain a fair distribution of MOSs for personnel responding to the questionnaire

Two hundred forty-three questionnaires were distributed to battalions during September-October 1984. One hundred

eighty-two completed questionnaires were returned for an overall response rate = 74.89%. Eight battalions from three active Divisions, including Hawaii and Twentynine Palms, were represented. See Table I. Twenty-seven questionnaires were distributed to each battalion for completion by a range of key personnel. Staff sections, commodity areas, and company offices were represented. Thirteen officers and 14 staff non-commissioned officers were the targeted respondents in the areas listed. See Table II for complete information. Table III lists the respondents' breakdown according to rank. Altogether, 12 ranks were represented in the results. As Table IV shows, 25 Military Occupational Specialties (MOS) were included in the sampling outcome.

TABLE I

Marine Corps-Wide Questionnaire Distribution Scheme

DIVISION	REGIMENT	BATTALION	# RETURNED	# DELIVERED
1st	1st	1stBN/9thMAR	20	27
1st	7th	2ndBN/7thMAR	27	27
2nd	2nd	2ndBN/4thMAR	24	27
2nd	6th	3rdBN/4thMAR	27	27
2nd	8th	3rdBN/8thMAR	24	27
3rd	4th	--	0	27
3rd	9th	3rdBN/7thMAR	18	27
1stMAB	3rd	1stBN/3rdMAR	17	27
MCAGCC	--	1stBN/4thMAR	25	27
		TOTAL	182	243
		Response Rate	=	74.89%
		Survey Period	-	Sep-Oct 1984

TABLE II

Questionnaire Distribution By Billet Per Battalion

BILLET	OFFICER	CHIEF
S-1	1	1
S-2	1	1
S-3	1	1
S-4	1	1
Motor Transport	1	1
Communications	1	1
Supply	1	1
Legal	1	1
BN. Career Planner	-	1
Rifle Company	Executive Officer	1st Sgt
Rifle Company	"	"
Rifle Company	"	"
Weapons Company	"	"
"H&S" Company	"	"
TOTAL	13 Officers	14 SNCO's

TABLE III

Respondents' Breakdown by Rank

Maj.	Capt.	1stLT.	2ndLT.	WO	MSgt.
1	30	45	13	3	6

1stSgt.	GySgt.	SSgt.	Sgt.	Cpl.	LCpl.
25	19	26	6	7	1

TABLE IV

Respondents' Breakdown By MOS

0121	0151	0170	0180	0193	0202	0231	0302
1	1	3	4	4	5	6	55
0311	0341	0369	0402	0431	2502	2519	2531
7	1	24	3	3	6	1	1
2537	2591	3002	3043	3521	3529	7501	7585
1	1	8	7	1	4	1	1
9999							
25							

1. Discussion of the Inferences

Based on the data obtained from the questionnaire results, a series of inferences about the infantry battalion administration system were developed. Discussion of the inferences follows (CI = Confidence Interval):

Information Production

1. Most personnel utilize either a manual or electric typewriter to produce typed output.
2. 38% indicated that 10-20 hours of typing is the average for a week.
3. Between 45-55% of typed output is either of a wholly standardized format or includes standard paragraphs

(CI: 45.83 < μ < 54.33). Operations orders, training schedules, appointment letters, NJP documentation, and morning reports are examples of standard format requirements.

4. Between 28-36% of a 40-hour work week is used for the purpose of revision typing (CI: 28.942 < μ < 35.492). Part of this is due to the constantly changing requirements within the battalion and the balance is due to spelling and typographical errors of the Marine typist.
5. Respondents indicated that between 51-63% of revision typing could be reduced if a text editing capability were available (CI: 51.772 < μ < 62.572). Overall system responsiveness to administrative requirements and the individual needs of Marines would improve markedly.
6. 96% indicated that the Marine who types and who employs a text editing capability would utilize the time saved to perform some other mission-related task. A company "clerk", normally pulled from a platoon, might be able to participate in unit training with his platoon, thereby contributing to unit readiness and individual MOS skills.

Information Transmission

1. 33% of the time administrative output is transmitted within the battalion by respondents. That is, key

command and staff personnel personally deliver output to its destination.

2. 53% of the time administrative output is transmitted within the battalion through the use of a designated "runner". Usually this is a Private First Class or Lance Corporal. Each company and most staff sections have Marines carrying out this functions.
3. A runner makes between 20-27 trips per week to pick up and deliver paperwork (CI: $19.775 < \mu < 26.695$). This refers to inter-building trips throughout the regimental area.
4. Between 18-23 minutes is the time per trip for the runner when picking up and delivering paperwork (CI: $18.06 < \mu < 22.34$).
5. Between 23-30% of all paperwork misses deadlines primarily due to the method employed to get it to its destination (CI: $22.67 < \mu < 29.95$). This "catch-up" situation strains command and staff relationships, as the timely exchange of essential information is the lifeblood of a battalion's administration system.
6. Between 15-22% of all paperwork is lost primarily due to the method used to transmit it within the battalion (CI: $15.111 < \mu < 21.051$). This not only has a bearing on the battalion's functional effectiveness in garrison, but it also ensures that continuous document retyping occurs.

7. 61% indicated that they were not satisfied with the current methods of transmitting administrative output within the battalion.
8. 83% indicated that the runner would use the time saved to accomplish some other task which contributes to unit mission readiness. Attending a first-aid class is an example.
9. Respondents indicated that between 10-14 hours per week could be saved through use of electronic messaging (CI: $10.285 < \mu < 13.105$). This would free-up time for key command and staff personnel to lead Marines more effectively.
10. 90% indicated that they would make use of an electronic messaging capability.

Information Management

1. 81% indicated that the administrative workload is increasing. This is worsened by the increase in weaponry and support items, which create reporting requirements, while at the same time there is a reduction in manpower due to the new T/O.
2. Between 30-42% of the time, it is necessary for respondents to obtain information, data, or "Green Machine" computer time prior to fulfilling administrative requirements (CI: $30.285 < \mu < 41.885$). Notably, in the infantry battalion environment, commodity

managers often use the Green Machine to calculate statistics for reports, commanders generate personnel rosters, and company 1st Sergeants commonly trek to Consolidated Administration to gather essential information from enlisted Service Record Books.

3. Between 26-43 minutes is the average length of time respondents indicated they were absent from their office when personally visiting Consolidated Administration to make use of the Green Machine, obtain information, and/or data (CI: $26.651 < \mu < 42.291$).
4. 96% indicated that the time saved by having in-office computer processing capability would be utilized to accomplish some other task which contributes to unit mission-readiness. Company 1st Sergeants can move away from being administrators and return to the business of being the company's senior enlisted leader.
5. Between 7-16 hours per month is dedicated to updating files (CI: $7.276 < \mu < 15.616$).
6. Between 4-7 hours per month is expended in searching for missing files that otherwise would not have been spent (CI: $4.228 < \mu < 6.722$).

Benefits

1. 82% agreed that a video screen text editing/revision capability would be a benefit. Administrative output quality would increase, clerical productivity would go up, and timeliness would improve.

2. 93% agreed that it would be a benefit to remain in the office and obtain data, information, and computer processing capability if such a method was available. Lieutenant Colonel Don Bonsper cites an application:

> "The electronic spreadsheet is the perfect tool for the rapid, accurate calculation of composite scores at the battalion/squadron level." [Ref. 23].

He describes a company commander's ability to quickly show a young Marine his composite score as a performance incentive/leadership tool. The existing method of computing composite scores is laborious and slow. Another useful spreadsheet-type application is inventory control at Battalion Supply. A spreadsheet would allow a supply officer to maintain a running on-hand equipment inventory count. The current system entails physical counting of items and use of IMR cards for equipment issue. Immediate on-hand inventory counts would reduce pilferage, loss, and mismanagement. Real dollar savings can result.

3. 81% indicated that it would be a benefit to remain in the office and provide or receive information through use of electronic messaging via computer video terminals. Currently, a limited number of overburdened, poor quality phones are used to send word of meetings, coordinate activities, and pass other information. An electronic messaging capability would reduce the amount of time wasted trying to get through on the phones,

provide an audit-trail of messages, and facilitate more effective intra-battalion communication. An excellent application might be to send morning reports and other repetitive items electronically. Easier correction capability would result.

4. 84% indicated that it would be a benefit to convert the current paper-based file system into an electronic data base which can be accessed from a computer terminal in the office. SRB information, archived operations orders, training schedules, class outlines, all reports, and organizational orders are a few examples of information that could be used quickly and effectively by key personnel.

General

1. 91% indicated that they are receptive to the idea of automating the administrative process.
2. 90% indicated that Marines in the office would be receptive to employing office automation equipment.
3. 85% indicated that Marines in the office are capable of effectively operating automated equipment.
4. 89% desire to see a training course accompany the implementation of office automation equipment.

C. FUNCTIONAL REQUIREMENTS

Section 2.a. of the MENS lists seven specific deficiencies that plague the battalion administration system.

Section B.2. of this chapter provides supporting data which describe the degree to which user requirements are not currently being met. Appendix D represents a master list of the infantry battalion's 141 functional requirements. Though not all-encompassing, Appendix D is a fair representation of current requirements. In order to assign functional requirements to identifiable responsibility centers (e.g., company office, commodity area, or staff section), the following list is provided. The numbers given per functional area correspond to numbered descriptions of specific functional requirements itemized in Appendix D:

Functional Area	Functional Requirements
C.O.	1,2,4-11,13-14,16-18, 20,22-29,34,39,45,48, 51-59,61-69,71,74-77, 79-81,92,94-95,97-100, 103-104,106-108,118-119, 141
X.O.	1,2,4-11,13,14,16-18,20, 22-29,34-39,45,48-59, 61-69,71,74-77,79-81, 88-92,94-95,102-104, 106-108,118-119,141
Sgt.Maj.	1,2,4-20,22-27,29,31-39, 43-45,48-53,55-59,61-69, 75,88,90-92,94-95,102-104, 106-108,118-119,141
S-1	1-20,22-30,33-38,40,45-81,85-92,94-96,99,102-109,117-119,126,141
S-2	1-35,37,39-40,42-45,47, 50,52,67-71,90-92,95, 97-98,103-109,119,141

S-3	1-20,22-29,31-35,37-45, 51-53,76-77,88-93,97-100, 103-105,108-110,119,124, 128,141
S-4	1-24,28-29,34-37,39-42, 51-53,76-81,83,90-94, 97-100,103-105,108-109, 115,117,119-121,124,126, 131-133,138,139-141
COMM	1-6,8-11,14,17-20,23-24, 28-35,37,39-42,45,52,70, 71,76,79,84,90-94,97-98, 105,108-109,111-117,119, 124,126-128,141
Supply	1-6,8-11,14,17-20,23-24, 28-35,37,39-42,45,52,76, 78,80-81,90-94,97-98, 103-105,108-109,112-113, 115-117,119-128,141
Motor-T	1-6,8-11,14,17-20,23-24 28-35,37,39-42,45,51,52, 76,79,82,90-94,97-98, 103-105,108-109,111,115- 116,119,124-141
BAS	1-6,8-9,11,14,16-18,20, 22-23,25,27-28,31-35,37, 40,45,52,56,85-87,90-92, 95,97-98,108-110,119,128, 141
Armory	14,16-21,23-24,29,33-34, 37,39,45,50-57,79,103, 112,115,126,131-136
"H&S" Co.	1-27,29,31-45,49-53,55- 58,63,65,67,74,79,85-88, 90-92,94-98,101-110,112- 113,117-120,126,128-130, 141
WPNS. Co.	1-27,29,31-45,49-53,55- 58,63,65,67,74,79,89-92, 94-98,101-110,112-113, 117-120,126,128-130,141

RIFLE Co.(3)	1-27,29,31-45,49,53,55-58, 63,65,67,74,79,89-92,94-98,101,112-113,117-120, 126,128-130,141
Legal	1-20,22-24,26,28-29,31-32, 34-37,45,48-52,61,68,90, 95,107-108,119,141
Career Planner	1-2,9-10,12-15,20,22,37, 49,75,90,95,107-108,118-119,141
PERS O (CONAD)	1-20,22-24,28-29,34,36-37, 39,43,45-46,49,51-52,56, 58,60,62,90-91,93,96,101, 104,106-109,118-119,129, 141

Each functional area either generates, distributes, receives, and/or files the requirements attributed to them. Figure 3.1 describes the matrix-type interrelationships which exist among all key elements of the infantry battalion.

ELEMENT	COMPANY	STAFF SECTION	BCAC	COMMODITY AREA
COMPANY	1,3,4	1,2,3	1,2,3	1,3
STAFF SECTION	1,4	1,2,3,4	1,2,3,4	1,3
BCAC	1,4	1,2,3,4	—	1,3,4
COMMODITY AREA	1,4	1,2,3,4	1,2,3,4	1,3,4

BASIS FOR INTERACTION

1. Information exchange
2. Reporting
3. Obtain service
4. Provide service

Figure 3.1 Battalion Functional Interrelationships

D. NEW CAPABILITIES REQUIREMENTS

In December 1983, IBM presented a study [Ref. 24] on the infantry battalion to the Commanding General, 1st MARDIV at Camp Pendleton, California. The findings included a list of new capabilities required for the infantry battalion. An adaptation of that list follows:

Telephone Communications

- Electronic transmission of information message (more than name and number)
- Ability to store and distribute messages
- Increased quantity and quality of phone lines

Information Production

- Sophisticated editing functions (spelling check, deletion, move paragraphs, reformat, etc.)
- Merge capability (creation of repetitive correspondence, reports, text and files, text and data)
- Electronic storage/retention of information produced
- Retrieve for document creation (template, standard paragraphs, etc.)
- Quality print capability (versatile typestyles and formatting)
- Automatic generation of charts, graphs
- Computation capabilities
- Creation and maintenance of file information currently on lists
- Simultaneous input/output

Information Transmission

- Electronic transmission of documents and messages
- Ability to browse index of "mail box"

- Automatic "standard" distribution lists
- Acknowledgment of receipt/delivery
- Access authorization for "mail box" use
- Edit documents, redistribute, file, and purge
- Indication of document priority

Information Management

- Centralized filing with multiple-user access
- Multiple level storage (diskette, central unit, host)
- Authorization levels (view only, view and print, print only, edit, edit and print, private)
- Flexible indexing
- Purging capability
- Storage capacity expansion capability
- File maintenance (add to, delete, change)
- Immediate automatic filing

Time Management

- Automatic reminders (with edit/"add-to" capability)
- Follow-up (request by date or subject)
- Events scheduling/planning capability
- View other key personnel/staff section schedules
- Archive calendars/schedules for command chronology record
- View battalion-wide calendar activity
- Create and maintain calendar information for future periods

The degree to which each functional area requires these new capabilities is best reflected in the list presented in paragraph C of this chapter. In attempting to optimize

administrative productivity within the battalion, it is important to note that automation capabilities must be carefully matched with unique user needs. Often, a new system will completely miss the mark on meeting the user's needs which originally prompted the request for a new system.

E. LAN DESIGN REQUIREMENTS

This section intends to draw attention to considerations which will influence the design of a Local Area Network which maximizes the possibility of meeting the needs of the infantry battalion.

1. General

a. Interface Requirements

The LAN proposed for the battalion should attempt to integrate existing network-capable equipment to the fullest extent possible. Resources planned for and now in use in the 1st MARDIV include IBM XT Displaywriter systems, IBM PCs, XEROX 627 Memorywriter electronic typewriters, and 3M EMT 9165 Digital Facsimile Transceivers. The 2nd MARDIV battalion resources are limited to one Televideo PC microcomputer. It is not known what the 3rd MARDIV employs. It is expected that interfacing current assets with a proposed LAN will be difficult. Maximum integration of existing assets into the LAN will reduce "buy-in" costs by minimizing the diversity and volume of new equipment needed upon installation. Yet, another question is the eventual possibility of linking the

battalion LAN to the BCAC's Green Machine. This has a far-reaching impact on the very concept of consolidated administration. Consideration of this possibility is appropriate. Also, a detailed survey of current battalion automation resources should be conducted prior to the initiation of the LCM-AIS concept development phase.

b. Communication Requirements

The Battalion Local Area Network is a system proposed to operate within the geographical area of a regimental camp. In most instances across the Marine Corps, this is a radius of less than one mile. It is a LAN proposed to communicate between nodes within the battalion. The basic plan does not initially call for extra-battalion communications via modems or other means, although this certainly is a feature of LAN growth capability. The attractive extra-battalion communication options include battalion nodes communicating with the BCAC's Green Machine and communicating as one level within a Battalion-Regiment-Division network. These applications raise the questions of improved quantity and quality of battalion phone lines, modem selection, transmission media, and interfacing with the "Green Machine's" JUMPS/MMS reporting system. The concept development phase should investigate these areas for LAN growth reasons.

c. Backup Capability Requirements

High system availability is essential, such that the infantry battalion may keep pace with an ever-growing

volume and complexity of requirements. This important feature can be enhanced through use of proven technology and adequate system redundancy.

Down-time is a de facto norm for many areas of infantry battalion operations. However, it never becomes an acceptable one. During the introduction of improved automation capabilities into the infantry battalion, it is essential to demonstrate to users that the new system is better and available. Gaining widespread user acceptance and faith is a goal central to the success of such a plan. Therefore, it is critical that the impact of network failures upon users be minimized by providing sufficient system redundancy. The requirements for backup capabilities include files, data bases, applications programs, and devices. Continuity of operations can be supported through design of a 20-node topology which includes 3 master-nodes, each of which may have identical application programs and user information stored on both hard disks and floppy diskettes. It is in this manner that valuable organizational information can be protected. Further, a topology should be selected such that the failure of any one or combination of nodes has the least impact on network operations for all remaining nodes. An objective of system redundancy is that failures should be as "transparent" to the user as possible. Lastly, it is desirable that sufficient device redundancy be built into the topology such that acceptable system availability will be maintained.

2. Specific

Desirable LAN attributes are:

- Adequate capabilities to meet existing battalion requirements
- Flexibility, such that network expansion can accommodate changing battalion requirements
- Simplicity, such that Marines can easily learn and operate the network
- Maintainability, in the form of responsive vendor maintenance support

The following design parameters are presented to define the framework within which the proposed infantry battalion LAN is reviewed in the next chapter:

1. Maximum connectivity - 27 nodes
2. Maximum node-to-node distance - 1,000m
3. Permit flexible resource sharing - Within a cluster of of up to 9 nodes (Maximum of 3 clusters in LAN)
4. Facilitate high data transmission rates - Exceeding 1 Mb/s
5. Facilitate low error rates - No more than one bit per 10^8 bits
6. Support diverse applications - Word processing, data base management systems, electronic spreadsheets, time management, electronic mail, and resource sharing
7. High system reliability - allow no more than 30% total network failure, up to a maximum down time = 4 hours, for any single occurrence
8. Rapid maintenance response - Provide a maintenance personnel response time no greater than 2 hours
9. High system availability - Ensure overall network availability, over a 30-day period and covering 4, 40-hour work weeks, not less than 95%
10. Flexible growth capability - Select network components

that will allow for network growth in connectivity, printing capabilities, fixed disk storage, and modem communication

The following chapter builds upon the foundation of functional requirements, new capabilities, and design parameters described here, an infantry battalion Local Area Network topology which will breathe life into several ideas and concepts promoted throughout this study: evolution of battalion consolidated administration, distributed data processing, and a model network which highlights the possibility of a Battalion-Regiment-Division network.

IV. THE BATTALION LOCAL AREA NETWORK

A. INTRODUCTION

Large organizations now face a significant problem of obtaining shared access to information. A commonly accepted rule of thumb states that 80 percent of shared information is generated, distributed, and used totally within a local environment - in our case, an infantry battalion garrison area [Ref. 25]. The LAN concept seeks to exploit this information generation, distribution, and use pattern by implementing a single, common network which serves the local information needs. The case developed throughout this study argues that electric typewriters, sparsely located microcomputers, and IBM "Green Machines" are incapable of satisfying a growing volume and complexity of local administrative requirements. This is accentuated by the fact that the Green Machine's top priority is to perform Class I data applications - those requirements external to the battalion. Given the information pattern described above, a Local Area Network would satisfy up to 80% of the infantry battalion's information requirements. One definition of a Local Area Network is:

> "Local area networks allow a great number and variety of machines to exchange large amounts of information at high speed over limited distances." [Ref. 26].

The following comment is a questionnaire response:

"Any new/improved equipment or type of automation would enhance our ability to better fulfill our administrative requirements." [Ref. 27].

The discussion which follows presents one possible approach to addressing the issue above. The succeeding section begins by describing the network concept.

B. IMPLEMENTING THE NETWORK

Local Area Network technology is both fairly new and rapidly changing. Though, there is no single LAN product which dominates the market, there is one company that is providing leadership and ongoing research which will increasingly influence the direction of LAN technology. IBM's Entry Systems Division has sponsored the development of the "PC Network". The IBM PC Network is used as the model for the LAN proposed for the infantry battalion. It is not the purpose of this research to promote this product or vendor specifically. Rather, the IBM PC Network effectively highlights the essential facets of current LAN technology.

1. LAN Concept

The premise underlying the concept is to implement a Distributed Data Processing system within the battalion so that identified functional areas may more efficiently produce, transmit, and manage the growing complexity and volume of administrative requirements, at a higher level of quality and timeliness, to the extent that overall command and functional

effectiveness is improved. This can be achieved by doing the following:

- Provide organic computer processing capability to the staff sections, commodity areas, and company offices
- Establish resource sharing and communication techniques between functional areas
- Maximize the "fit" of local area network technology to the infantry battalion organizational structure. This is accomplished by balancing processing capacity, node location, connectivity, and routing technique considerations. Achieving an equilibrium between these factors makes it more likely that the users' needs will be met - this is the objective function of LAN implementation.

The twenty functional areas identified in Chapter III will participate as nodes in the IBM PC Network-based infantry battalion local area network.

> "The IBM PC Network is a low cost broadband peer-to-peer communication (underline mine) among IBM Personal Computers, IBM Portable Personal Computers, IBM Personal Computer XTs, and IBM Personal Computers ATs in a shared resource environment (underline mine)." [Ref. 28].

The network resources employed are:

1. IBM Personal Computers and Personal Computers ATs
2. Network Adapter Cards
3. A Network Translator Unit
4. Network Cabling Components
5. PC Network Programs (DOS 3.1)

These resources are discussed more specifically in a later section which describes how the resources are distributed in the network. See [Ref. 29] for a complete and detailed technical description of the IBM PC Network.

A useful manner in which to understand the PC Network

scheme is to visualize the data flowing along the following route:

Data - Transmitting terminal (DOS 3.1) - Network Adapter Card - Cabling Segment (25, 50, 100, 200 ft. lengths) - Cable Distance Kit units (200, 600, 1000 ft. lengths) - Base Expander Unit (Concentrator of incoming data paths) - Network Translator Unit (Broadband frequency translation) - Data propagated on sending channel to receiving terminal via path above in reverse order

The definition of the PC Network cited previously, mentions: broadband, peer-to-peer communication, and a shared resource environment. The succeeding section takes a more detailed look at four parameters:

- Transmission technique
- Transmission medium
- Access protocol
- Network topology

a. Transmission Technique

The transmission technique for the PC Network is broadband. A single cable is capable of transmitting a "broad" range of analog frequencies, hence the name. The Frequency Division Multiplexing (FDM) aspect of broadband systems allow many devices to share a single cable by assigning specific transmission frequencies to each connected device. Accordingly, broadband is regarded as a high throughput technique. An attractive feature of broadband systems is the capability to transmit data, video, and voice signals. Although, the PC Net does not currently permit video and voice signals, it is anticipated that it's

likely to become available later. The advantage to the infantry battalion might be video conferencing between key personnel vice meetings. Secondly, broadband transmission media are high quality, high speed, and reliable; future capability for voice communications would alleviate the current stress on overburdened, poor-quality phone lines within the battalion area. Essential intra-battalion communications would be improved. A summary of characteristics of the broadband transmission technique are:

- High bandwidth typically = 300 MHz
- High speed = 10 Mb/s maximum each channel
- Low error rates (one bit error per every 10 to the tenth bits)
- Voice, video, and data capabilities

b. Transmission Medium

The transmission medium employed to conduct broadband analog signals in the PC Network is 75 ohm coaxial CATV cable. Coaxial cable offers the versatility of supporting the broadband technique's high bandwidth by being able to reliably support data, video, and voice communication over a wide range of frequencies. Coaxial cable attributes are:

- Coaxial cable technology is mature and well understood
- Skill levels needed to connect devices are readily available. Marine Corps Base Communication/telephone sections have personnel capable of installing such cabling
- Minimal emanations of electrical or magnetic signals. This feature contributes to network security and data protection. Enhanced security of classified data transmission is afforded

- Coaxial cable is immune to noise, such as interference, cross talk, lightning, and corrosion

c. Access Protocol

Carrier Sense Multiple Access/Collision Detection (CSMA/CD) is the access protocol employed by the PC Net. Carrier sense indicates that each workstation has the ability to detect any traffic on the data channel (commonly known as listen-before-talking). Network nodes defer data transmission when traffic is "sensed" on the channel. The multiple access feature allows any node to transmit data immediately upon sensing the channel is free of traffic. Collisions occur when 2 stations attempt to transmit data at exactly the same time (network propagation delay prevents each node from sensing the other node's traffic at the same instant). Collision detection is the ability of a transmitting node to sense a change in the channel energy level and to interpret it as a collision. The transmitting node's adapter card will employ a random back-off algorithm and attempt to retransmit the data accordingly. Because of technical characteristics peculiar to a broadband system, the difference in signal strength between 2 transmitting nodes must be small in order for collisions to be detected. The PC Net employs a "balanced network" concept. This is where the signal strength between a transmitter and receiver is equal. IBM accomplishes this by establishing one network where transmitter signal strength to one centralized receiver is equal. The second network maintains equal signal

strength between one centralized transmitter and a receiving station. The location for the centralized receiver and transmitter is referred to as the headend part of the NTU. The NTU translates and amplifies the signal received at the centrally located receiver (the adapter card's transmit frequency) to the centrally located transmitter's frequency (the adapter card's receiver frequency). CSMA/CD ensures fair distribution of network access to staff section, company, and commodity area nodes. This is combined with the broadband system's high speed and high-bandwidth channel, so that there is adequate capacity to facilitate access by any node virtually at any point in time [Ref. 30]. This contribute's to the infantry battalion's confidence in a LAN, because availability remains high and wait time is minimized. Gaining the acceptance of users is critical to the success of implementing a LAN. Reducing user frustration, by any method, is highly desirable. In this context, CSMA/CD is a valuable parameter.

d. Network Topology

Topology refers to the physical layout of the medium used to connect network nodes. The infantry battalion LAN topology is a STAR configuration. This is a 20 node network divided into 3 "clusters" of 6 or 7 nodes each. The three clusters are arranged according to functional similarities. They are: Headquarters Cluster, Companies Cluster, and the Support Cluster. Each cluster has a master node which serves as a file, print, and message server for resource

sharing purposes. The 3 master nodes are: S-1, "H & S" Company, and Consolidated Administration. Each master node employs a "powerful" microcomputer in order to facilitate resource sharing control. The remaining 17 nodes utilize standard microcomputers. Traditionally, a STAR topology indicates centralized communications control implemented by a central controller. This is not the case with the IBM PC Network. The battalion LAN is a peer-to-peer communications network where each terminal's network adapter card performs all network functions and protocol processing. The distribution of control of network functions among the twenty nodes greatly lessens the vulnerability a network might experience were a central controller used. The absence of a single critical node normally found in STAR topologies contributes to network reliability. Though network control is distributed, network data flows from nodes to the Network Translator Unit which conducts frequency translation and amplification of incoming signals. It is in this sense that the topology is STAR configured, because the NTU is a logically centralized location within the overall network design. However, there is no requirement for the NTU to be physically located at the geographic center of the battalion LAN coverage. The NTU should be placed where it best supports outlying nodes while minimizing the total network cabling length. Since the NTU is a small, self-contained, and self-operating "black-box" there is not necessarily a requirement to co-locate it with

a node for the purpose of monitoring or maintenance. In order to ensure maximum reliability, this LAN topology calls for one backup NTU so that it may be readily brought on-line in case of primary NTU failure. In the event of node failures, the remainder of the network experiences no impact whatever. Another feature is that STAR topologies boast ease of connection for additional nodes. This allows the LAN to meet the unique needs of the infantry battalion and to adapt to changing requirements.

There are basically 2 methods of physically organizing infantry battalions within Regimental Areas: 1. Headquarters building with all staff sections; company offices, commodity managers, and CONAD each in separate buildings; 2. Headquarters building (multi-story) with all staff sections and company offices; CONAD and commodity managers each in separate buildings. The following Regimental areas are organized according to the former criterion: 1st MAB, 5th MAR, 8th MAR, and 9th MAR, and 7th MAR, are arranged in consonance with the latter description. Generally, the first method is a more geographically dispersed battalion area which requires careful analysis to determine optimum connectivity, while minimizing cable length and complexity. Fortunately, the flexibility of the STAR topology accommodates such geographic dispersal. The second method consolidates 12 nodes in one headquarters building and this greatly reduces

cable length, complexity, and installation difficulties. Figure 4.1 is provided as a depiction of the LAN topology.

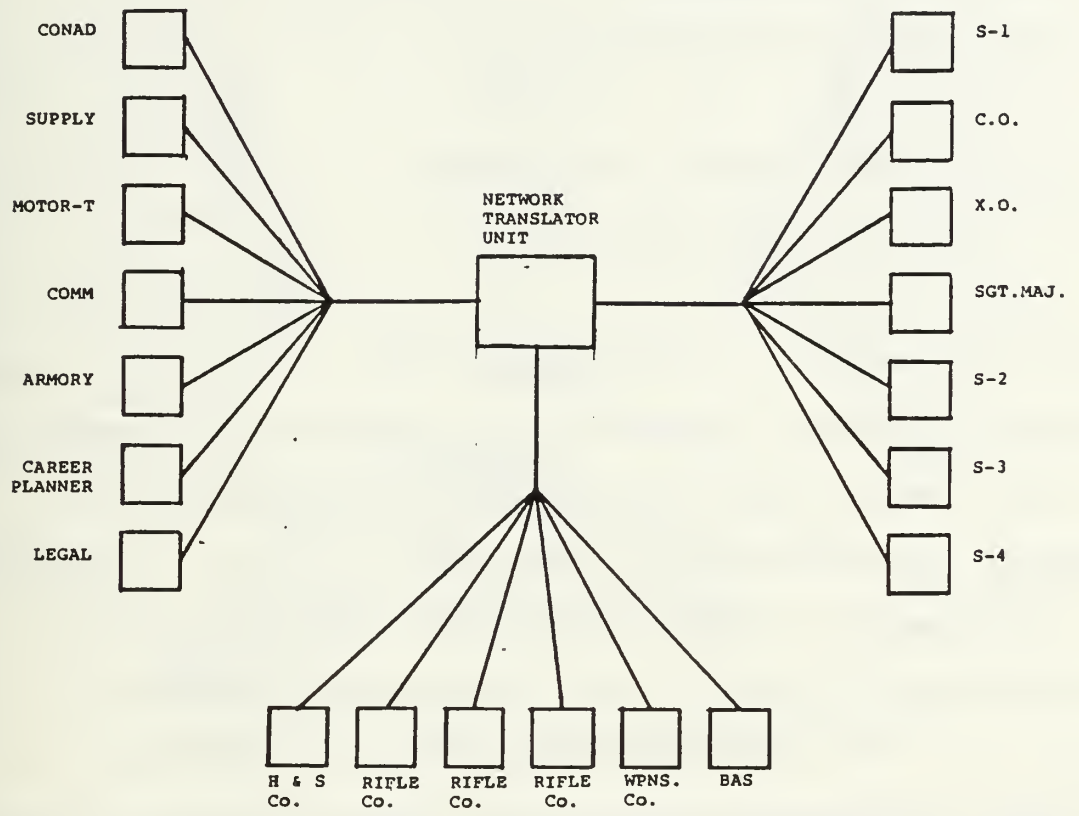

Figure 4.1 LAN Topology

2. Network Resources

The following minimum resources are required for each of the 17 basic nodes in the battalion LAN:

- One double-sided diskette drive
- 128 KB of RAM
- An 80-column display with adapter
- An IBM PC Network Adapter Card
- DOS 3.1

For the 3 master nodes which will function as file, print, and message servers, the listed prerequisites must be met:

- One fixed-disk drive
- One double-sided diskette drive
- 256 KB of RAM
- An 80-column display with adapter
- An IBM PC Network Adapter Card
- DOS 3.1
- An IBM compatible print device [Ref. 31].

Appendix E provides a detailed and comprehensive breakdown of the total network resources required for implementation. A complete cost summary is provided also.

Given the resources described in Appendix E, the infantry battalion LAN is to be configured according to Figure 4.2. Each master node is provided an IBM PC-AT "powerful" microcomputer which functions as the file, print, and message servers. A desktop, letter-quality printer is located at each master-node, with the exception of S-1 and the addition of S-3. In the S-1's case, a high speed printer is located to handle a heavy volume of queued printing jobs within the headquarters building to support staff functioning. Also, S-3 is provided a desktop, letter quality printer in order to expeditiously output training schedules, operations orders, training area requests, etc., while avoiding slowing down the S-1's printing thruput were that device to be used by the S-3. It is estimated that one desktop

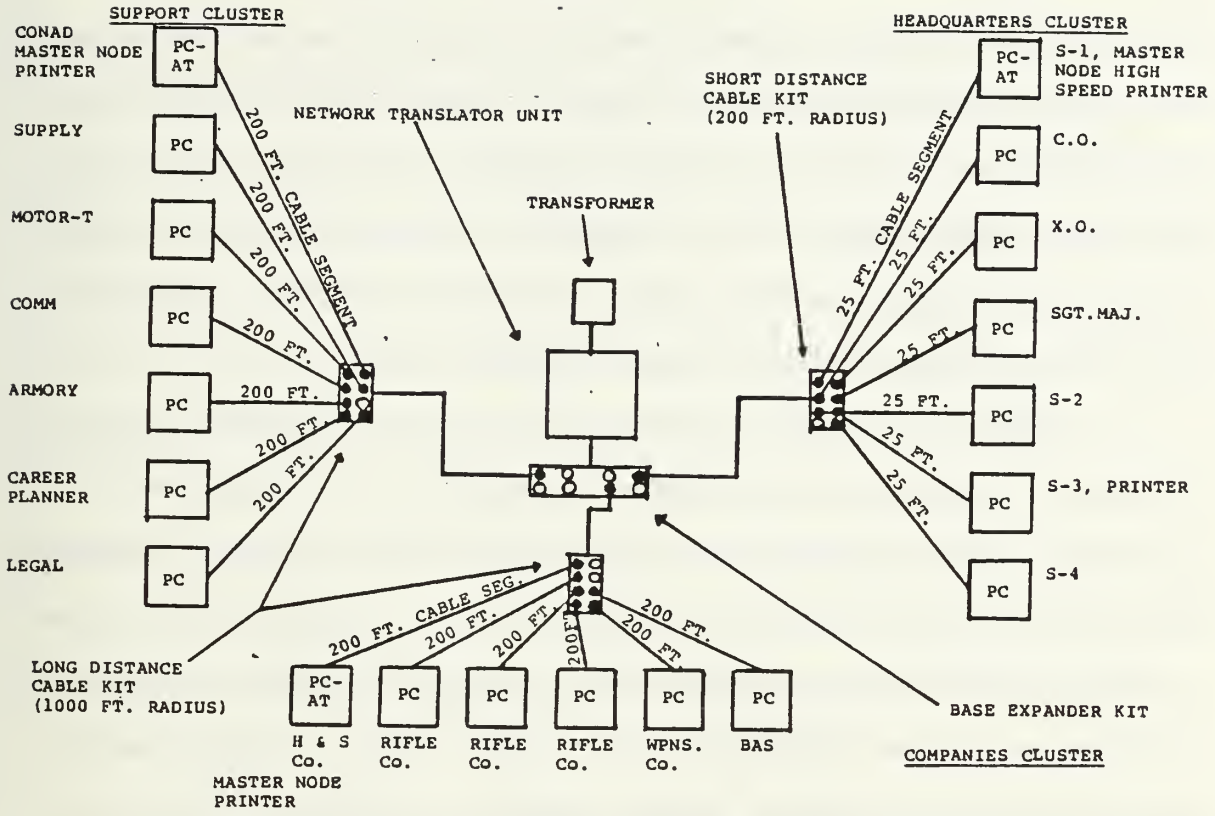

Figure 4.2 LAN Resources Configuration

printer per the remaining clusters, Support and Companies, will be sufficient to support their requirements. This is so because a highlight of LAN implementation is the movement of information closer to and among users, as opposed to merely more paper. Indeed, by providing just one printer to the Companies Cluster, the spirit of the BCAC concept (Removing the burden of administration, typewriters, and admin clerks from the company offices) can still be fulfilled because the emphasis is on instant user access to information and not necessarily company responsibility for administration based on paper-flow - one printer for the six nodes in the Companies

Cluster is intended to support only a moderate level of hard-copy output in those cases where that method is necessary and when "soft-copy" is unable to satisfy the unique situational requirements. This is a clear example where new technology and the current BCAC can successfully merge, while not mand-dating significant procedural overhaul and, even, improving administrative efficiency and effectiveness.

The 17 basic nodes are provided with an IBM PC micro-computer capable of workstation processing and resource sharing. Each workstation is provided with a floppy diskette drive in order to maintain control of and responsibility for locally (node-unique) generated or required information. While much of the information can be stored on hard-disk at one of the master nodes, floppy diskette drives provide a valuable means of backup capability. The IBM PC Network pro-vides each workstation with a unique address. These addresses are employed when node-to-node communication takes place, as in resource-sharing. While each cluster is based on similar functional groupings and file and print resource sharing should take place primarily within individual clusters, this flexible network allows stations to go outside their assigned clusters to access, retrieve, and/or print information. Of course, in electronic messaging this freedom certainly applies.

The question of specifically where a workstation video terminal is to be physically located within a

functional area's office is crucial. Should the company commander, commodity manager, and staff officer have the terminal on their desks, or should they be relegated to other locations? Would a Company 1st Sgt. or Executive Officer better employ the node's resources? Who should be primarily responsible for operating the keyboard and associated input-output functions - a SNCO, junior officer, commander, or corporal? These critical questions can only be adequately answered by each battalion's command policy. That is, it should be a function of command to determine how to best employ and place network resources. These issues should not be resolved by the imposition of a Marine Corps-wide policy, because such a policy would fail to exploit the traits of individual leadership present in key personnel assigned to unique infantry battalion environments.

This LAN resource configuration provides for significant applications software capabilities: word processing, DBMS, electronic spreadsheet, electronic mail, and time management. These applications provide the network users with tremendous ability to manipulate raw data and transform it into valuable organizational information which can be easily accessed, rapidly transmitted, observed locally, and safely stored. The number of copies of each application listed in Appendix E is the estimated requirement for an infantry battalion. These numbers are provided without regard to where the applications are located within the

network and who may employ them. Again, this must be resolved by battalion policy. Distributing processing power among 20 network nodes provides great capabilities to functional area users, but it also has management control implications. This issue and others are the subject of the following section.

C. IMPLEMENTATION GUIDELINES

1. Management Control

Distributing processing power among the 20 identified functional areas in the battalion accomplishes these objectives:

- Moves data entry function to user locations
- Makes users (companies, staff sections, and commodity areas) responsible for data entry completeness, accuracy, and timeliness
- Enhances immediate data validation, as user devices can quickly correct errors while source documents are available

However, these and other advantages of DDP can be easily overshadowed by problems if proper management control (Marine Corps leadership) is not exercised concurrently with the introduction of LAN technology into the infantry battalion. A superb definition of management control, which is particularly well-suited for the infantry battalion environment, is:

> "Management control is a pragmatic concern for results, obtained through people." [Ref. 32].

This definition emphasizes two specific principles:

- Management control highlights results, which are defined as goal attainment within the local organization (infantry battalion) and/or a larger one (USMC)

- The most important principle is that management control focuses on people in organizations

This study has proposed establishing a LAN within the infantry battalion. The purpose of a LAN is to improve upon the existing BCAC-based administrative system. In order to ensure that the operation of this information system remains in consonance with the mission of the infantry battalion, the following implementation guidelines are presented within the management control framework:

- Publish a letter from the commanding officer to key personnel that implementation of a battalion LAN is pending and that such a system has command backing. Demonstration of command commitment is crucial to the success of new information systems. This is particularly the case in the infantry battalion where automation is still relatively unknown

- Establish the position of Battalion Information Systems Management Officer (BISMO). The officer appointed, preferably from the headquarters cluster (proximity to command guidance), will be responsible for overall LAN operations. The BISMO function should become a 1st Additional Duty and BISMO performance should be evaluated on the officer's fitness report. A job responsibility without performance evaluation is soon a forgotten one. This also meshes well with the command commitment notion

- Establish the position of Node Officer (NO) for each of the 20 functional areas included in the network. These officers are the designated "responsible" officers for node resources and they should have a dotted-line communication relationship with the BISMO. They are responsible for maintaining the operation of their node within command policy guidelines. The NO function should be designated as a collateral duty. The reporting senior should evaluate NO performance and use it as input to the officer's fitness report

- Publish a Battalion Standard Operating Procedures (SOP) for LAN operations. This comprehensive document should cover: reporting, network security, network access, maintenance, user procedures, applications, classified

data, hours of operation, information systems planning, performance standards, and LAN objectives. This SOP should be unique to a particular infantry battalion

- Publish, disseminate, and update a users' manual. This provides detailed information on overall network operations and specific procedures for keyboard operators at nodes

- Establish a battalion LAN users' group. The group comprises the BISMO and NOs. It should meet periodically to discuss pertinent issues, identify problems, and exchange information regarding LAN operations

- Publish specific auditability standards with regard to data, hardware and software features. Desirable properties of DDP auditability policy are: predictability, controllability, ease of examination, and transaction verification

- Conduct scheduled, periodic inspections of each node to assess battalion information systems readiness, verify conformance with the Battalion SOP for LAN operations, and to perform auditability examinations

- Minimize LAN hardware and software movement between nodes

- Establish a communication channel from NOs to BISMO to the Division ISMO. This is to take advantage of technical expertise at Division, obtain programming assistance, and to exchange mutually beneficial information

- Implement a Battalion Information Systems Planning (BISP) system. Require BISMO to publish an 18-month BISP which will assess current IS readiness, identify problems, forecast future requirements, and delineate battalion information systems objectives. Bottom-up input from nodes should be obtained and the BISP should be updated quarterly. The 18-month planning cycle will correspond to the 18-month battalion deployment cycle. This parallel planning will contribute to maintaining information system congruence with the infantry battalion's mission

2. Education/Training

Battalion key personnel who are responsible for managing the operation of the LAN should be exposed to educational opportunities that will assist them. Some useful

topics are: LAN technology, applications capabilities, and information systems planning. Educational presentations should be conducted prior to implementation in order to prepare personnel for the impending arrival of new technology. Also, it should be conducted periodically to keep personnel current with the latest information. Both vendors and Division ISMOs should provide the presentations.

Training courses should be directed toward the Marines who will be operating the node resources on a daily basis. The range of ranks involved might be Lance Corporal to 1st Sergeant. Areas covered should be: terminal input-output procedures, software applications instruction, user's manual familiarity, keyboard training, troubleshooting aids, start-up, backup, and recovery techniques, and hardware features. Training courses should be conducted on-site on a periodic and continual basis. The combination of educating key personnel and training operators increases user confidence in the system, facilitates effective management of the LAN, and reduces user frustration during network operations.

3. Network Security

Network security refers to the protection of expensive LAN resources from damage and/or theft and the protection of organizational data from intentional disclosure to unauthorized individuals, unauthorized alterations, and/or destruction. The physical security of LAN resources can be enhanced by:

- Careful placement of resources where adequate supervisory monitoring can take place

- Use of the terminal key-lock feature, as provided by the LAN design. Secure the terminal keys after working hours and release the key to authorized personnel only. Maintain a key log and have individuals sign-out for keys

- If possible, site resources in a locked office

- Maintain a detailed list of node resources, to include serial numbers of hardware items

- Conduct periodic inventories of node resources to ensure components have not been transferred, damaged, or stolen

- Require duty NCOs to periodically sight node resources during off-duty hours

The following guidelines will assist in preventing harm to organizational data:

- Positive identification of users

- Supervisory approval and system acceptance of user actions

- Install network capability to monitor user actions. Reinforce this with supervisory review of user actions. Make it known that malicious intent will be dealt with severely under the UCMJ

- Ensure data auditability

- Make data reconstructible

- Maximize tamperproof features of network resources

- Comply with Privacy Act requirements

- Consider data base replication and data distribution

A battalion resource/data security plan should be developed to prevent, say, occurrences of a Lance Corporal keyboard operator changing PFT scores, EST results, or supply inventory counts for profit or other reasons. A three-pronged plan includes:

- Minimizing threat probability by preventive measures
- Minimizing damage when it occurs
- Developing a sound damage recovery methodology

4. Network Access

A key component of network security is the aspect of who is authorized to do what on the battalion LAN. Information is a valuable organizational asset and it must be aggressively protected from unauthorized access. Three methods which serve this function are use of passwords, privacy locks (much like a safe combination), and data encryption. Authorization schemes like the ones above can be based on:

- Individual groups or categories of users
- Classification level (top secret, secret, or confidential)
- Transaction type
- Individual terminal or its unique location
- Time of day (e.g., no access after working hours)
- Application programs

Further, the following restrictions can be applied:

- A user may be identified and locked out of a terminal, node program, or requested data
- A specific workstation might be located in an insecure area and locked out of specific programs, nodes, or data
- A program may be excluded from accessing certain data
- Classified data may be prevented from being stored in a specific storage device authorized for lower or non-classified data levels

Each IBM PC or PC-AT in the network has a unique node name. Each adapter card in these machines can store up to 16 user names for use in access authorization. The BISMO should develop a precise access authorization scheme which provides an optimum methodology for facilitating, controlling, and monitoring user access to the battalion LAN and its resources. Four desirable characteristics of a Network Access Plan (NAP) are:

- Exploit the advantages of access features present in LAN hardware and software resources
- Flexible, to accommodate changing passwords, privacy locks, node addresses, and cryptographic keys
- High degree of physical security of NAP implementation details
- Should be regularly monitored by the BISMO and NOs for irregularities. Reports of unauthorized access attempts and other procedural aberrations can assist the BISMO and NOs in identifying specific vulnerabilities in network access control

D. ISSUES RELATED TO IMPLEMENTATION

1. Tactical Considerations

This study previously defined the scope of this LAN application to that of a battalion's garrison area. In this regard, the study has not discussed how a battalion LAN might function in the field, aboard ship, or in a combat environment. An information systems is implemented to support an organization's mission. A complete discussion of a LAN for the Marine Corps Infantry Battalion should definitely include tactical considerations. In September 1984, the

1st MARDIV met with success in employing a network of "Green Machines" and Grid Portable Personal Computers to support the staff functioning of the Division command group during a Command Post Exercise (CPX). Studies such as this one and real-world applications of LAN technology in field conditions should serve to galvanize a directed approach within the Marine Corps to address this most important issue.

2. Battalion-Regiment-Division Network

The LAN topology and resource configuration presented is feasible, both, practically and technologically for the infantry battalion garrison areas. A regimental camp, within which one may find three discrete battalion LANs, and none of which talk to one another or to higher headquarters, seems to be an incomplete step forward along the continuum of progress. Bottom-up network design does not imply that network design should remain at the bottom of the organizational ladder. Rather, it is the foundation upon which network technology implementation filters up the chain-of-command, such that the overall organizational structure may eventually be served by a planned and coordinated information systems. Perhaps, it is desirable to connect the 3 infantry battalion LANs to the Regimental Headquarters building? Again, it seems possible that Regimental reporting, communications, and coordination might improve. In each of the 3 Divisions, regimental camps are geographically dispersed from Division headquarters. Given present technology, it is doubtful that linking

Regiment to Division headquarters by cable is possible. However, currently, there are microwave links in place which facilitate message traffic within the Division. Is it not possible that the regimental links to the Division Wide Area Network (WAN) can be accomplished in this manner, or through use of fiber optics some day? It is in this vein that such a Battalion-Regiment-Division network is proposed to serve the Division organizational structure.

3. Automation Not A Threat To Leadership

> "There are 3 primary objectives in designing an electronic office for an executive or professional:
> 1. That they spend less time on paperwork
> 2. That decision-making capability be improved
> 3. That human communications be improved." [Ref. 33].

This description of automation is not a nefarious plot indicating a subtle transition in the Marine Corps from leadership to management; it is speaking to leadership! The resounding answer that the LAN technology presented in this study provides is that it is intended to make more effective the application of leadership by key personnel within the infantry battalion's increasingly complex and pressure-laden organizational setting. Automation is not a replacement for face-to-face meetings, personal phone calls, command functions, or troop-leading steps. Rather, it is a modern tool which busy and challenged leaders may use to carve out more time during a time-critical work-day for these very same activities. The only threats automation represents are:

- Educating Marines about new and improved ways of performing battalion administration

- Threatening to greatly reduce paperwork
- Increasing productivity
- Improving information access and flow
- Threatening to improve the quality, accuracy, and timeliness of communication

4. Pilot-Prototype-Production Concept

The pilot-prototype-production concept commonly refers to the phased implementation of information systems. Usually, implementation begins on a small scale and is divided into stages. Subsequent to the implementation of each stage, an evaluation is conducted to assess system performance and effectiveness. This feedback becomes the input to the next stage, which deals with a larger system. This process is repeated iteratively until the overall information system is installed and operating within the organization. The advantages are:

- Minimization of risk with, initially, small system implementation
- Dollar costs of a pilot project are minimized according to the scale of initial system
- Permits system evaluation at periodic intervals to assess performance and effectiveness. This facilitates fine-tuning successive stages of the proposed information system
- Develops valuable corporate knowledge and experience with system operations and procedures prior to implementation of the complete information system within the overall organization

The STAR topology of the battalion LAN has attractive features which can exploit the advantages of a flexible

pilot-prototype-production plan. Dividing the topology into 3 functionally related clusters allows LAN implementation to be phased-in by clusters. Secondly, the topology facilitates relative ease of individual node connection to the network. This allows the network, both, to grow and to adjust its configuration during the fine-tuning process.

The pilot-prototype-production concept, as it applies to the phased implementation of the battalion LAN is:

1. Pilot Phase - Install the Headquarters Cluster of the LAN in one selected infantry battalion. Conduct network operations for 3 months, evaluate performance results for 1 month, and refine battalion LAN concept for 2 months

2. Prototype Phase - Install the complete battalion LAN in one selected infantry battalion. Conduct network operations for 6 months, evaluate performance results for 1 month, and refine battalion LAN concept for 2 months

3. Production Phase - Periodically phase-in the LANs in each of the 27 Marine Corps infantry battalions over an 18-month period

4. LAN Benefits-Analysis

The purpose of this section is to demonstrate tangible dollar savings that can be generated upon implementation of the LAN. The underlying premise is that the listed benefits will result in an overall increase in productivity among key personnel within the battalion. This benefits-analysis serves more as an initial "back-of-the envelope" estimate intended to provide decision makers with a frame of reference, rather than to establish an iron-clad economic threshold upon which a go or no-go decision is

based. Though, this analysis does not take into account 3 specific cost areas and the time value of money, the numbers represented are a worthy starting point for a detailed and comprehensive economic analysis. Finally, it should be emphasized that this analysis does not quantify many possible benefits, such as: improved readiness, increased "fighting-hole" strength, and better decision making.

The LAN proposed in this study will cause the following annual dollar savings to accrue to the infantry battalion, as per benefit category, upon implementation:

1.	Information Production -	$26,784.68
2.	Information Transmission -	23,220.80
3.	Information Management -	4,841.03
4.	Information Access/Processing -	36,901.20
	Total Annual Savings	$91,747.71

Appendix F gives a detailed breakdown of how the figures are derived.

The initial investment cost, minus annual maintenance, supplies, and installation costs, of the battalion LAN is:

Investment Cost	$88,292.00

The annual savings generated are:

Total Annual Savings	$91,747.71

The use of the payback analysis technique allows determination of the length of time it will take for a new system to generate cost savings sufficient to cover the investment cost. The formula employed is:

$$\text{Payback} = \frac{\text{Investment Cost}}{\text{Annual Savings}}$$

Applying this formula yields:

$$\text{Payback} = \frac{88,292.00}{91,747.71} = .962 \text{ years}$$

This figure means that in slightly less than one year of battalion LAN operations, the full investment cost can be recovered through savings generated. While this simple technique has the drawback of not taking into account the time value of money, it does provide an estimate useful in establishing an economic frame of reference (Using a discount rate = .10 and a factor = .91, the net present value of the annual savings = $83,399. Inserting this number into the formula yields a payback period = 1.06 years).

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This study has reviewed infantry battalion administration within the context of the Battalion Consolidated Administration Center concept (BCAC) and a growing complexity and volume of administrative requirements. The MENS identified deficiencies intrinsic to the current system. The Infantry Battalion Administration Questionnaire documented the degree to which a comprehensive list of functional requirements is presently not being met. Distributed Data Processing (DDP) was highlighted as one possible route along which the BCAC may evolve, in the form of implementing an Infantry Battalion LAN. Both the technological feasibility and economic viability of this proposal support the case.

In light of the foregoing synthesis of key aspects of this discussion, the following conclusions are made:

1. That there exists a need for the BCAC concept to evolve
2. That there is a need for the Information Systems Branch (HQMC) to conduct centralized planning with regard to implementation of information systems specifically at the unit level, such as the infantry battalion
3. That Distributed Data Processing is one possible migration path for the BCAC
4. That the Infantry Battalion LAN proposed here is, both, technically realistic and economically attractive

5. That, upon consideration of a proposal such as this one, the issue of tactical deployment of a battalion information systems must be studied carefully

B. RECOMMENDATIONS

The succeeding recommendations are presented for the purpose of establishing a reasonable starting point for Marine Corps decision-making, with regard to this proposal:

1. Conduct a detailed and comprehensive requirements analysis of a selected infantry battalion in order to provide a solid foundation for the LCM-AIS concept development phase

2. Survey all infantry battalions to determine a Marine Corps-wide perspective of automation equipment currently on-hand

3. Perform a detailed and comprehensive economic analysis of viable alternatives suggested during the investigation phase

4. Conduct high level planning for the future implementation of information systems on the unit level (this is as opposed to general policy guidelines to Divisions; chart a migration path along which local commands may determine how best to get there)

5. As automation capability increases on the unit level, improve the communication channel between the Information Systems Branch, Division ISMOs, and unit representatives

6. Consider a long-range possibility of establishing a primary MOS for unit Information Systems Management Officer (e.g., BISMO)

7. Initiate a study to investigate automation applications for the infantry battalion in a deployed environment

8. Establish more effective coordination between the Information Systems Branch, the USMC representative to the U.S. Naval Postgraduate School, Curriculum #367, and Marine students. This will facilitate enhanced continuity of research into ongoing information systems-related problems

APPENDIX A

INFANTRY BATTALION ADMINISTRATION QUESTIONNAIRE

INFANTRY BATTALION ADMINISTRATION QUESTIONNAIRE

This questionnaire is part of a study which is investigating how the infantry battalion administrative and logistics processes can be automated. The study is being conducted at the U.S. Naval Postgraduate School and it is sponsored by HQMC (Code: CCI). The purpose of the questionnaire is to collect information about current administrative requirements, office equipment, and procedures unique to the infantry battalion administrative process.

Instructions:

1. Do not list your name, but do fill in requested information.
2. Where applicable, circle letters, check appropriate space, or fill in a number; where appropriate, feel free to select multiple answers.
3. Where numerical responses are requested, your best estimate is sufficient.
4. Return questionnaire to battalion headquarters.

Rank/MOS/Billet_____/_____/_____

Section/Company/Battalion/Regiment____/____/____/____

Questions

I. Information Production:

1.A. What method do you employ to produce typed output?

A. Manual Typewriter
B. Electric Typewriter
C. Memory Typewriter
D. Dedicated Word Processor w/Printer
E. Microcomputer w/Printer
F. Other (Please specify) _____

7. What percentage of the typed documents you produce require retyping because of content changes and/or errors? (Total should = 100%)

A. None ____% B. Once ____% C. Twice ____%
D. Three or more times ____%

8.A. Out of a 40-hour work week, estimate the average number of hours of typing performed in your office.

A. 0-10 hours/week
B. 10-20 hours/week
C. 20-30 hours/week
D. Greater than 30 hours/week

B. What percentage of this time is for the purpose of revision typing? _____%

9.A. If you or your office had a video screen test editing/revision capability, would you consider this a benefit? Yes/No

B. By what percentage would you estimate your revision typing could be reduced? _____%

C. For the individual performing the typing duties, would the Marine use the time saved above to fulfill some other task or objective which would contribute to your unit's mission readiness? Yes/No

11. What percentage of typed output is either of a wholly standardized format or includes standard paragraphs? _____%

12. Would you consider a computer capability which automatically updates numerical figures, based on your input, and incorporates the new "totals" into a pre-specified standard format a benefit? Yes/No

13.A. Under current procedures, is it often necessary for you to obtain information, data, or "Green Machine" computer time prior to fulfilling your administrative requirements? Yes/No

B. If yes, what percentage of your workload requires this step? _____%

C. Are there designated hours for personnel in your office to use the "Green Machine"? Yes/No

E. Do you personally visit Consolidated Administration to accomplish the step described in "A"? Yes/No

F. How long are you absent from your place of work per trip? ____ mins/trip

G. Do you consider this to be a detriment to your ability to carry out your normal duties? Yes/No

H. If there were a method available to you which allowed you to remain in your office and obtain information, data, or computer processing capability, would you consider this a benefit? Yes/No

15.A. Considering the type of information or data you either provide or receive from others in the instances listed in 14, for routine cases, would you consider it a benefit if you were able to remain in your office and accomplish the above through use of electronic messaging via computer video terminals? Yes/No

B. How much time per week would you save? hrs/week

C. If such a system were available, would you use it? Yes/No

16. Is your administrative workload?

A. Increasing B. Decreasing

C. About the same as a year ago

II. Information Transmission:

17. By what method do you transmit administrative output to its destination within the battalion (Total = 100%)

		Percentage of Instances
A.	Personally delivered by yourself	_____%
B.	Use of a designated "runner"	_____%
C.	Use of a "Guard Mail" system	_____%
D.	Other (Please specify)	_____

18.A. Are you satisfied with the methods listed above?

Yes/No

C. What percentage of paperwork do you estimate misses deadlines primarily because of the method employed to get it to its destination?

_____%

E. What percentage of paperwork is lost primarily due to the method used to transmit it within the battalion? _____%

19.A. What is the average number of trips per week the "runner" makes to pick up and deliver paperwork?

_____ trips/week

B. What is the average time per trip for the "runner"? _____ mins/trip

20.A. If there were a means of electronically transmitting administrative output within the battalion available to you, would you consider this a benefit? Yes/No

C. Would you make use of a system described in above? Yes/No

D. Would the "runner" use the time saved to accomplish some task or objective which contributes to mission readiness? Yes/No

21. Estimate the average hours per week saved as a direct result of being able to transmit and receive information electronically. hrs/wk

III. Information Management:

25.B. What is the average amount of time per month dedicated to this task? hrs/month

26. How much time is expended per month searching for missing files that otherwise would not have been spent? hrs/month

28.A. Would you consider it a benefit if you had the means to convert your paper-based file system into an electronic data base which you could access from a computer terminal in your office? __Yes/No__

B. Might some of the benefits be:

A. Reduction in paper-based files

B. Reduction in lost information

C. Reduction in retyping of lost information

D. Reduction in searching for lost information

E. Increased ability to follow-up actions

F. More effective resource management

G. Improved response quality and time

H. Other (Please specify) _____

29.A. If you were able to electronically access and utilize other information within the battalion which assisted you in the performance of your duties, would you consider this a benefit? __Yes/No__

IV. General:

30.A. Would you consider it a benefit to "pass and receive the word" via messages on video screens as opposed to meetings? __Yes/No__

31. Would it be a benefit to send morning reports and other similar repetitive items electronically? Yes/No

32.A. Are you receptive to the idea of automating the administrative process? Yes/No

B. Do you feel that Marines in your office would be receptive to employing office automation equipment? Yes/No

C. Do you feel that these Marines are capable of effectively operating such equipment? Yes/No

33. Would you desire to see a training course accompany the implementation of office automation equipment?

A. Strongly desire B. Nice to have

C. Makes no difference D. Opposed to the idea

34. Add any other comments you desire. _____

APPENDIX B

DATA ANALYSIS METHODOLOGY

The questionnaire basically elicits two types of responses: (1) Either a yes or no or; (2) A numerical answer. Percentages were yielded in the former case for 23 questions and/or parts. For the latter type, 13 questions and/or parts produced numbers which were utilized in constructing confidence intervals.

For the yes/no questions (proportions), the following formula was used:

Formula	Description
$z = \frac{x-np_0}{np_0(1-p_0)}$	Statistic for large-sample test concerning proportions
x = Observed # of responses	$\alpha = .05$ level of significance
n = Sample Size	$Z_\alpha = 1.645$ (One-sided test)
p_0 = Hypothesized Probability	
p = Observed Probability	

Because n is large for every question in the survey, the tests conducted are based on the normal-curve approximation to the binomial distribution. The implicit assumption is that there are n independent trials, each of which has the same probability = p of success. In most cases, $p_0 = .5$ is assigned as there is an equally likely chance of

selecting either a yes or no response. In all other remaining questions, where the respondent is able to select $\underline{1}$ of any $\underline{x}$ choices, the p_0 assigned is $p_0 = \frac{1}{x}$, where p_0 = hypothesized probability of selecting any $\underline{1}$ of $\underline{x}$ equally likely choices. In order to test for statistical significance, a one-tailed hypothesis test at the 95% confidence level was conducted for the applicable questions. The null hypothesis, $H_0 : p \leq p_0$, was rejected and the alternative hypothesis, $A : p > p_0$, was accepted when the calculated z value $> z_\alpha$. In this instance, statistical significance is confirmed [Ref. 34].

For the 13 questions and/or parts yielding numerical responses, confidence intervals were constructed. The formula used is:

Formula	Description
$\bar{x}-z_{\alpha/2} \cdot \frac{s}{\sqrt{n}} < \mu < \bar{x}+z_{1-\alpha/2} \cdot \frac{s}{\sqrt{n}}$	Large-sample confidence interval for μ
$\bar{x}$ = Observed sample mean	α = 95% level of confidence
n = Sample size	$z_{\alpha/2} = 1.96$
s = Sample standard deviation	

Confidence intervals are constructed so that it is possible to determine the interval within which the estimated population mean will be located, based on observed sample data, at a specified level of confidence. In the case presented here, the sample comprises a cross-section of key administrative personnel from 8 of 27 infantry battalions.

The population consists of key administrative personnel from all 27 Marine Corps infantry battalions. The observed sample mean for each question is utilized in the confidence intervals to estimate what the population mean will be for every question. It is in this manner that the questionnaire develops useful information about the infantry battalion administration system. All confidence intervals are at the 95% level of confidence. [Ref. 35].

Refer to Appendix C to view the questionnaire data. The following formula was used to calculate the sample means:

$$\bar{x} = \frac{\sum x}{n}$$

x = Observed responses

n = Sample size

In order to calculate the sample standard deviations, this formula was employed:

$$s = \sqrt{\frac{\sum (x-\bar{x})^2}{n-1}}$$

x = Observed responses

$\bar{x}$ = Sample means

n = Sample size

In the far right-hand column of Appendix C, statistical significance is either affirmed or denied, or a confidence interval is indicated as applicable.

Question #/Part	Choice	# of Responses	N	Mean	Std. Dev.	Yes	No	%	Significant Or Confidence Interval
1.A.	A	80							
	B	104							
	C	17							
	D	3							
	E	3							
	F	8							
7.	A	105		45.114	30.6				
	B	137		42.591	27.7				
	C	113		27.212	21.4				
	D	61		22.770	24.3				
8.A.	A	52	177					29.3	No
	B	68						38.4	Yes
	C	33						18.6	Yes
	D	24						13.5	Yes
B.			165	31.982	20.2				CI
9.A.			171			140		81.8	Yes
							31	19.2	
B.			157	57.172	34.6				CI
C.			182			174		95.6	Yes
							14	4.4	
11.			162	50.080	27.6				CI
12.			172			136		79	Yes
							36	21	
13.A.			177			100		56	Yes
							77	44	
B.			82	36.085	26.8				CI
C.			169			57		33.7	
							112	66.3	Yes
E.			152			83		54.6	No
							69	45.4	
F.			85	34.471	36.8				CI
G.			122			63		51.6	No
							59	49.4	

Question #/Part	Choice	# of Responses	N	Mean	Std. Dev.	Yes	No	%	Significant Or Confidence Interval
H.			158			147		93	Yes
							11	7	
I.			151			145		96	Yes
							6	4	
15.A.			166			134		80.7	Yes
							32	19.3	
B.			118	11.695	7.81				CI
C.			166			149		89.7	Yes
							17	10.3	
16.	A	141	174					81.1	Yes
	B	1						0.6	No
	C	32						18.3	Yes
17.	A	150		32.813	26.8				
	B	158		53.373	27.2				
	C	92		29.946	26.5				
	D	24		20.208	20.2				
18.A.			173			68		39.3	
						105		60.7	Yes
C.			129	26.310	21.2				CI
D.			149	18.081	18.6				CI
19.A.			163	23.245	22.5				CI
B.			160	20.200	13.9				CI
20.A.			173			148		85.5	Yes
							25	14.5	
C.			171			151		88.3	Yes
							20	11.7	
D.			159			132		83	Yes
							17	17	
21.			144	13.840	12.7				CI
25.B.			157	11.446	26.7				CI
26.			116	5.5086	6.69				CI
28.A.			174			147		84.5	Yes
							27	15.5	

Question #/Part	Choice	# of Responses	N	Mean	Std. Dev.	Yes	No	%	Significant Or Confidence Interval
B.	A	125	182						Yes
	B	125							Yes
	C	115							Yes
	D	119							Yes
	E	119							Yes
	F	103							Yes
	G	117							Yes
29.A.			172			158		91.8	Yes
							14	8.2	
30.A.			170			107		62.9	Yes
							63	37.1	
31.			166			144		91.8	Yes
							22	8.2	
32.A.			175			159		90.8	Yes
							16	9.2	
B.			174			157		90.2	Yes
							17	9.8	
C.			182			154		84.6	Yes
							28	15.4	
33.	A	153	171					89.5	Yes
	B	7						4	No
	C	6						3.5	No
	D	5						3	No

APPENDIX D

INFANTRY BATTALION FUNCTIONAL REQUIREMENTS

1. Naval Correspondence
2. Special correspondence (CONGRINT, SPLINT, and WELREP)
3. Postal functions
4. Awards documentation
5. Discharge documentation
6. Request Mast
7. NJP documentation
8. Pro/Con marks
9. Fitness Reports
10. Composite scores
11. Promotion documentation
12. Administer Privacy Act
13. PCS, TAD orders
14. Leave requests, papers
15. Personnel Action Requests (PARs)
16. Duty logbook
17. Duty rosters
18. Recall rosters
19. Mess/Maintenance/Guard rosters
20. Alpha rosters
21. Armory Access Lists
22. Reenlistment documentation
23. Morning reports
24. Appointment Letters
25. Shot Lists
26. JAG Manual Investigations
27. Dental Screening lists
28. Staff Papers (Decision, Point, etc.)
29. Authorization letters
30. Directives Control Point
31. Class rosters, outlines
32. Training handouts
33. Equipment, Inventory lists
34. Training schedules
35. Operations Orders
36. Courts Martials documentation
37. Maintain turnover file
38. Command Chronology Report
39. Rifle/Pistol range rosters
40. Logistics requests
41. Air support requests
42. Training area requests
43. PFT rosters/scores
44. EST training forms
45. Casualty reporting
46. Typing support

47. CMS/CMCC duties
48. PMO blotter
49. Commander's schedule/meetings
50. Guard orders
51. SIRs
52. Deployment rosters
53. Predeployment report
54. Officer Billet report
55. MOS Breakdown report
56. Personnel Breakdown report
57. FY, Monthly NJP Totals report
58. Personnel Status report
59. Non-EAS Attrition report
60. 01 Personnel Status report
61. Confinement Statistics report
62. Monthly UA totals report
63. Racial/Ethnic report
64. FY, Monthly STAR reports
65. FHTN report
66. Non-T/O Billet report
67. Drug/Alcohol Information report
68. Urinalysis Screening report
69. Drug/Alcohol Quarterly report
70. CMS/CMCC Destruction report
71. Classified Message Log report
72. Chaplain's report
73. Postal Inspection report
74. Education Breakdown report
75. Career Planning report
76. Combat Essential Equipment report
77. Combat Essential Weapons report
78. Supply Personnel report
79. T/E Deficiencies report
80. SAC 1 T/E Losses report
81. Fiscal report
82. Motor-T T/O & T/E report
83. S-4 Personnel report
84. Comm T/O & T/E report
85. Medical Status report
86. Corpsmen Strength report
87. Dental report
88. Rifle Range/PFT/EST report
89. BFTD report
90. DET plan
91. Quarterly Training Schedule
92. Pre-Deployment Training Schedule
93. Embark Load report
94. Motor Vehicle Accident report
95. Drug Exemption report
96. SRB Control form

97. Intelligence summary
98. Intelligence report
99. Logistics Status report
100. Embark personnel report
101. JUMPS/MMS reporting
102. SRB/OQR Control functions
103. Rifle/Pistol cards
104. ID/Meal cards
105. Ration memorandums
106. Visual Audit Sheets
107. AA Forms
108. Readboard functions
109. Publications Control
110. Training records
111. Unit Audit Listing
112. IMR cards
113. ECR cards
114. CMR Listing, Comm.
115. ERO Shopping/Transaction list
116. ERO logback
117. Responsible Officer letters
118. EAS Roster
119. Planning Calendar
120. Personal Effects Lists
121. Mechanized Allowance Lists (MAL)
122. MAL logbook
123. Security Cage Sub deck Cards
124. Equipment Density Lists
125. Monthly POR/TFB Closeout Sheet
126. Requisition Forms
127. Interim receipts
128. Ration Memorandum reports
129. Allotment requests
130. Clothing records
131. Daily Sight Inventory
132. Weekly Inventory report
133. Monthly Inventory report
134. SL-3 logbook
135. Temp Loan logbook
136. Weapons logbook
137. Separation Enlistment Voucher
138. Energy Conservation report
139. Ammunition logbook
140. Ammo. Expenditure report
141. Counseling functions

APPENDIX E

NETWORK RESOURCES WORKSHEET

Item	Quantity	Unit Price	Cost
IBM PC-AT System Unit 512 KB RAM 1.2 Mb Diskette Drive 20 Mb Fixed Disk w/ serial, parallel interface	3	$4,056	$12,168
IBM PC System Unit 256 KB RAM 2,320 KB Drive & Adapter	17	1,694	28,798
Network Adapter Card	20	486	9,720
Monochrome Display Card Printer Adapter	20	175	3,500
Monochrome Display	20	192	3,840
IBM 5224 System Printer 240 lpm, Impact Matrix	1	1,795	1,795
IBM 5201 Quietwriter 60 cps, Letter quality	3	1,395	4,185
IBM PC Keylock Feature	17	35	595
Network Translator Unit	2	416	832
Network Cabling Kits			
Short Distance (200 ft.)	1	27	27
Long Distance (1000 ft.)	2	62	124
Cabling Segments			
25 ft. cable	7	20	140
200 ft. cable	13	69	897
Base Expander Kit	1	41	41
DOS 3.1	20	45	900
IBM PC Network Program	20	52	1,040
Wordstar, Word Processing	15	299	4,485

Item	Quantity	Unit Price	Cost
DBASE II, DBMS	15	299	4,485
Lotus 123, Spreadsheet	10	399	3,990
IBM Interactive Network and Message System (INNET/INMAIL), Electronic Mail	20	210	4,200
IBM Planning Assistant, Calendaring/Time Management	20	104	2,080
TOTAL HARDWARE & SOFTWARE COSTS =			$88,292

All IBM product prices are referenced from the August 1984 IBM/GSA price list. Remaining item prices are from commercial sources.

APPENDIX F

LAN BENEFITS CALCULATIONS

1. Information Production

   Application: Text editing/revision capability

   Scope: All 14 questionnaire respondent functional areas (see Table II)

   Ranks: E-3

   Assumption: One E-3 typist in each of 14 questionnaire respondent functional areas will perform word processing

   Inferences: 2,4,5

   Calculation:

   $7.58 \frac{\text{hrs}}{\text{wk}} \times 40 \frac{\text{wks}}{\text{yr}} \times 6.31 \frac{\$}{\text{hr}}\ (\text{E-3}) \times 14\ \text{E-3s} = \$26,784.68$

2. Information Transmission

   Application: Electronic messaging

   Scope: 5 companies, Motor-T, Comm, Supply

   Ranks: E-3

   Assumption: Electronic messaging capability would replace 1 E-3 runner's efforts in 8 questionnaire respondent functional areas

   Inferences: 3,4,9

   Calculation:

   $11.5 \frac{\text{hrs}}{\text{wk}} \times 40 \frac{\text{wks}}{\text{yr}} \times 6.31 \frac{\$}{\text{hr}}\ (\text{E-3}) \times 8\ \text{E-3s} = 23,220.80$

3. Information Management

   Application: Electronic filing/storage

   Scope: All 14 questionnaire respondent functional areas

Ranks: E-3

Assumption: Electronic filing/storage would reduce excessive information searching and filing by 1 E-3 clerk in all 14 questionnaire respondent functional areas

Inferences: 5,6

Calculation:

$1.37 \frac{\text{hrs}}{\text{wk}} \times 40 \frac{\text{wks}}{\text{yr}} \times 6.31 \frac{\$}{\text{hr}}$ (E-3) X 14 E-3s = 4,841.03

4. Information Access/Processing

Application: In-office information access and computer processing capability

Scope: All 14 questionnaire respondent functional areas

Ranks: E-8(lstSgt.) and E-3

Assumption: In-office information access and computer processing would obviate need for Company lstSgt.s to personally visit CONAD to observe, record, and obtain SRB information; E-3's from functional areas wouldn't need to process requirements on Green Machine

Inferences: 2,3,4 (Information Management)

Calculation:

$7 \frac{\text{hrs}}{\text{wk}} \times 40 \frac{\text{wks}}{\text{yr}} \times 15 \frac{\$}{\text{hr}}$ (E-8) X 5 E-8s = 21,000.00

$7 \frac{\text{hrs}}{\text{wk}} \times 40 \frac{\text{wks}}{\text{yr}} \times 6.31 \frac{\$}{\text{hr}}$ X 9 E-3s = 15,901.20

Total Annual Savings = $91,747.71

Notes

1. The lst figure, representing savings, in each calculation is obtained from one of the questionnaire inferences listed for each category

2. In deriving the 1st figure of each calculation, the midpoint of the confidence interval is employed

3. The 2nd figure in each calculation is arrived at by deducting 4 weeks annual leave and 8 weeks of field training from 52 available weeks. This is intended to provide a conservative estimate

4. The 3rd figure in each calculation is the hourly labor rate for the pay grade indicated. [Ref. 36] provides the Marine Corps FY-84 Composite Standard Rates by pay grade

5. The 4th figure in each calculation is the number of pay grades, represented by questionnaire respondent functional areas, who experience the reduction in labor hours as a result of the added application in each category

LIST OF REFERENCES

1. Division Adjutant, 1st MARINE DIVISION Memorandum 5272/7 to Commanding General, 1st MARINE DIVISION (REIN) FMF, subject: FSC7435 Office Information Systems Equipment (OISC) Feasibility Study, p. 2, 13 FEB 1984.

2. U.S. Marine Corps, FMFM6-3, Marine Infantry Battalion, p. 1, 1978.

3. U.S. Marine Corps, 1st MARINE DIVISION, Battalion Consolidated Administration Manual (DIVO P5000.20), p. 1.1, 1981.

4. Ibid., p. 1.1.

5. Ibid., p. 1.2.

6. Ibid., p. 1.2.

7. Martin J., Design And Strategy For Distributed Data Processing, p. 3, Prentice-Hall, Inc., 1981.

8. Champine, G. A., Distributed Computer Systems: Impact On Management, Design, and Analysis, p. 115, North-Holland Publishing Company, 1980.

9. King, J. L., "Centralized Versus Decentralized Computing: Organizational Considerations and Management Options," CACM, vol. 15, no. 4, p. 337, December 1983.

10. Ibid., p. 323.

11. Champine, G. A., Distributed Computer Systems: Impact On Management, Design, and Analysis, p. 16, North-Holland Publishing Company, 1980.

12. Martin J., Design And Strategy For Distributed Data Processing, p. 17, Prentice-Hall, Inc., 1981.

13. Breslin, J. and Tashenberg, C. B., Distributed Processing Systems: End Of The Mainframe Era, p. 12, AMACOM, 1978.

14. Martin J., Design And Strategy For Distributed Data Processing, p. 82, Prentice-Hall, Inc., 1981.

15. Nolan, R. L., "Managing The Four Stages of EDP Growth," Harvard Business Review, vol. 52, no. 1, p. 76, January-February 1974.

16. U.S. Marine Corps, FMFM6-3, Marine Infantry Battalion, p. 1, 1978.

17. Division Adjutant, 1st MARINE DIVISION Memorandum 5272/7 to Commanding General, 1st MARINE DIVISION (REIN)FMF, Subject: FSC7435 Office Information Systems Equipment (OISC) Feasibility Study, p. 2, 13 FEB 1984.

18. Oren, S., Lieutenant Colonel, USMC, Text Processing Study Of A Marine Corps Infantry Battalion, report presented to the Commanding General, 1st MARINE DIVISION (REIN), Camp Pendleton, California, p. 3, 19 December 1983.

19. Commanding General, 1st MARINE DIVISION Letter 5000/7 to Commandant of the Marine Corps(CCIS), Headquarters, U.S. Marine Corps, Subject: Request for Microcomputer Acquisition, p. 1, 23 Apr 1984.

20. Commanding General, 1st MARINE DIVISION Letter 5200/7 to Division Supply Officer, 1st MARINE DIVISION, Subject: Purchase of Electric Typewriters, 5 Jul 1984.

21. Interview with Capt. Samples, USMC, 2nd MARINE DIVISION ISMO, Camp Lejeune, North Carolina, 241500 Sep 1984.

22. Questionnaire respondent, "Infantry Battalion Administration Questionnaire", September 1984.

23. Bonsper, D. E., "Learning The Electronic Spreadsheet," Marine Corps Gazette, p. 34, October 1984.

24. Gulotta, C. F., Marketing Manager, National Accounts Division, IBM, Corporation, IBM Presentation For The 1st MARINE DIVISION report presented to the Commanding General, 1st MARINE DIVISION (REIN), California, p. 22, 30 December 1983.

25. Digital Equipment Corporation, Introduction to Local Area Networks, p. 13, 1982.

26. Ibid., p. 14.

27. Questionnaire respondent, "Infantry Battalion Administration Questionnaire", September 1984.

28. International Business Machines Corporation, "IBM PC Network," IBM Personal Computer Seminar Proceedings vol. 2, no. 5, p. 2, September 1984.

29. Ibid., p. 1.

30. Digital Equipment Corporation, Introduction to Local Area Networks, p. 59, 1982.

31. International Business Machines Corporation, "IBM PC Network," IBM Personal Computer Seminar Proceedings vol. 2, no. 5, p. 24, September 1984.

32. Euske, K. J., Management Control: Planning, Control, Measurement, and Evaluation, p. 2, Addison-Wesley Publishing Company, Inc., 1984.

33. Martin J., Design And Strategy For Distributed Data Processing, p. 587, Prentice-Hall, 1981.

34. Freund, J. E. and Williams, F. J., Elementary Business Statistics: The Modern Approach, p. 365, Prentice-Hall 1982.

35. Ibid., p. 305.

36. U.S. Marine Corps, Marine Corps Cost Factors Manual (MCO P7000.14), 1984, p. 2-13.

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